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PERFECT QUALITY AND AUDITORY PERSPECTIVE IN THE TRANSMISSION AND REPRODUCTION OF MUSIC[1]

By Dr. FRANK B. JEWETT

BELL TELEPHONE LABORATORIES

IT is quite impossible in the short space of the fifteen or twenty minutes allotted to me to attempt anything in the way of detail, either in the matter of the scientific principles involved in the apparatus and equipment of this particular system of music transmission or in the elaborate arrangement of parts involved in the demonstration to be given in Constitution Hall next Thursday evening. As a matter of fact, all the scientific material has been or will be incorporated in various technical papers. Further, the demonstrations which Dr. Harvey Fletcher is proposing to give at the time of the Thursday demonstration will be more illuminating than anything which I could hope to reproduce here.

All that I propose to do, therefore, is to outline briefly the fundamentals of the problem, the extent to which we have succeeded in solving them, and the general arrangement of parts which will be employed in the transmission and reproduction of a complete symphonic concert from the stage of the Academy of Music in Philadelphia to the stage of Constitution Hall in Washington.

For the perfect pick-up, transmission and reproduction of orchestral music a system is needed, such that the sound reproduced in the ears of the listener is the same as that which would be produced in his ears if he were listening to the orchestra directly. In other words, the frequency, intensity and phase relations of the sound in each ear must be accurately reproduced in order best to convey the frequency and intensity range of the sounds and the spatial relations of the instruments. So far as we now know, this can be done

[1] Presented to the annual meeting of the National Academy of Sciences, Washington, D. C., April 25.

only by means of a binaural telephone system, using two head receivers for each listener. In other words, to obtain what might be called an acoustic facsimile, a separate telephone system must be used for each ear of the listener. Such an arrangement was necessarily employed in working out the arrangements which have been developed, although for obvious reasons it was never contemplated that such a system could ever be used for a general audience.

Although such a facsimile can not be produced by means of loud-speaking telephones, it is possible by their means to reproduce music which has auditory perspective, and which in many ways gives just as pleasing an effect as though it were a perfect facsimile. As an illustration of how this might be accomplished, it is possible to imagine a system of microphones and sound projectors which will approach facsimile reproduction as follows.

Suppose the stage of the music hall is acoustically insulated so that the only sound reaching the audience is that coming through the opening occupied by the curtain when it is lowered. If now a large number of microphones are distributed over the plane occupied by the curtain when it is lowered and each microphone is connected to a loud speaker similarly placed before the audience where the music is to be reproduced, then if the microphones, the loud speakers and the connecting lines have the right characteristics, the audience should receive sound which is a very close approximation to the original. In such a system the microphones must be so small as not to interfere with the free passage of the sound waves and must produce an electrical facsimile of the sound waves in front of them. Similarly, each of the connecting lines must be distortionless. The loud speakers must be very small and must produce an acoustic facsimile of the electrical waves. At the present time, we do not know how to produce loud speakers of this character. Even if we did know how to produce them, the expense involved would be prohibitive on account of the amount and complexity of apparatus required and of the cost of the multi-channel connecting lines. Fortunately, however, experience has shown that a very close approximation to complete facsimile reproduction can be obtained by using a three-channel system. With such a system the auditory illusion is substantially complete except for those persons sitting very near to the stage.

Broadly speaking, the frequency range which is needed to secure perfect reproduction is the entire frequency range that is audible to the human ear. However, tests with reproduced orchestral music have shown that the elimination of the frequency range below 30 or 40 cycles per second and that above 15,000 cycles per second is hardly detectable. These eliminated frequencies are very close to the audible limits for the average person.

A full-sized symphonic orchestra is capable of producing sound through an intensity range of about 65 or 70 db. For perfect reproduction any electrical system to be satisfactory must be capable of handling an intensity range of at least this amount. The range that a system can handle is determined by the difference between the noise level and the overload level. When a system capable of handling a greater intensity range than that ordinarily produced by an orchestra was finally developed musicians were quick to take advantage of it as a means of increasing the sound intensity during crescendo passages above normal and in decreasing the intensity during very soft passages below normal. This indicates apparently that the intensity range, which an ideal system should be capable of handling, is set by the range between the loudest sounds that a listener can hear comfortably and the faintest sounds that he can hear in a quiet audience. This range is somewhere between 80 and 100 db, depending upon the character of the music. Roughly, such an ideal system will produce maximum sounds in crescendo periods about ten times as loud as those which a one hundred piece orchestra is capable of producing directly.

Characteristics of the Pick-up Microphones Employed and Their Location

The characteristics of the microphones which have been developed for this reproducing system are described in two papers entitled, "Moving-Coil Telephone Receivers and Microphones," by Wente and Thuras, and "A Sensitive Moving-Coil Microphone of High Quality," by Thuras.

Characteristics of Loud Speakers Employed and Their Location

Each loud speaker assembly employed in reproducing transmitted music consists of three units. One of these units is of large dimensions and is designed for the perfect reproduction of frequencies below 300 cycles per second. The remaining two units, which are small and alike, are designed for the perfect reproduction of all frequencies above 300 cycles per second. These two small units are mounted on top of the low frequency unit and the combination of the three units is so designed and arranged that the entire frequency band of sound is distributed uniformly throughout the hall.

Characteristics of Power Amplifiers

Time does not permit any detailed description of the power amplifiers which it is necessary to employ

in order to obtain the requisite amount of energy. Suffice to say, these amplifiers must have substantially flat amplification characteristics for all frequencies at all intensity levels and must be capable not only of maintaining continuously these characteristics for the normal sound range of the orchestra, but must also be capable of handling for short periods and without distortion the greatly increased sound range in crescendo passages.

Quasi-Binaural Arrangement Employed

As is shown in Fig. 1, three complete channels are used. Each channel consists of a microphone, amplifier, volume control, connecting line and loud speaker.

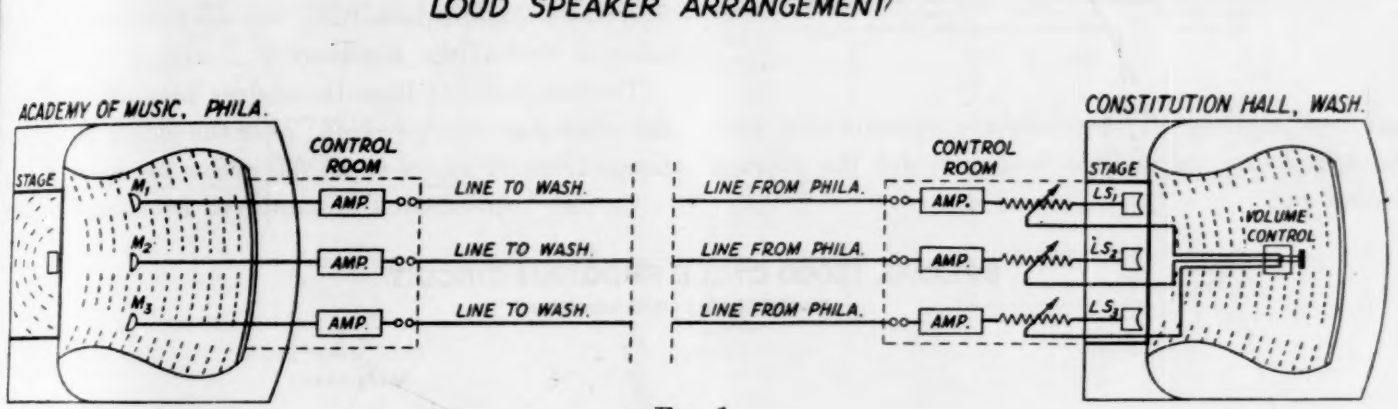

FIG. 1

In the Academy of Music in Philadelphia, the microphones are placed about ten feet in front of the stage and ten or twelve feet above the floor. These microphones are connected to loud speakers in corresponding positions on the stage of Constitution Hall, *i.e.*, the microphone at the left of the Philadelphia stage connects to a loud speaker at the left of the Washington stage, etc. Thus, the three channels, left, center and right, reproduce the sounds arising in corresponding positions on the Philadelphia stage.

Method of Volume Control which Dr. Stokowski Will Employ

In the system to be demonstrated in Constitution Hall Thursday evening, provision is made for Dr. Stokowski to control the volume of sound from the loud speakers on the stage of Constitution Hall while seated at a monitoring position in the audience at Constitution Hall. He will also have facilities for communicating directly with the orchestra on the stage at the Academy of Music in Philadelphia. The general features of the plan for the demonstration are to transmit without change the program to Washington as it is picked up at Philadelphia. The unchanged program coming to Washington may then be changed at will by means of the volume control before reaching the loud speakers on the stage of Constitution Hall. The volume control which Dr. Stokowski will use permits of changing the three channels simultaneously as a group or of changing each individually as he may elect in order to obtain any desired tonal coloring.

The response characteristic of the overall system is obviously dependent upon the acoustic properties of the rooms in which the sounds are picked up and reproduced. In order to obtain a proper overall characteristic, the loud speakers were put on the stage at the Academy of Music and connected to an electrical oscillator. The pick-up microphones were hung in their proper positions in front of the stage. The electrical power developed by the transmitters was compared with the electrical power supplied to the loud speakers for sinusoidal waves in the frequency range 40 to 15,000 cycles per second. The system was then equalized so that the power ratio was a constant over the entire frequency range. Since each channel of the system is capable of furnishing a steady acoustic power of at least 35 watts at any frequency in the entire range, the three channels together are capable of furnishing at least 100 watts of power. In the middle of the frequency range several times this amount of power can be produced without distortion. When the energy frequency distribution of orchestral music is taken into account, it turns out, as was indicated earlier, that the system is capable of magnifying the total sound output of a one hundred piece orchestra about tenfold.

Audible Frequency Range for Music, Speech and Noise

As a matter of passing interest, Fig. 2 shows the audible frequency range for speech and for various kinds of noises and musical instruments which the system is capable of reproducing without noticeable distortion. As will be seen, these frequencies extend from the deep low notes of the bass viol and bass tuba to the high frequencies emanating from the snare drum, cymbals, violin, oboe, footsteps, hand-clapping

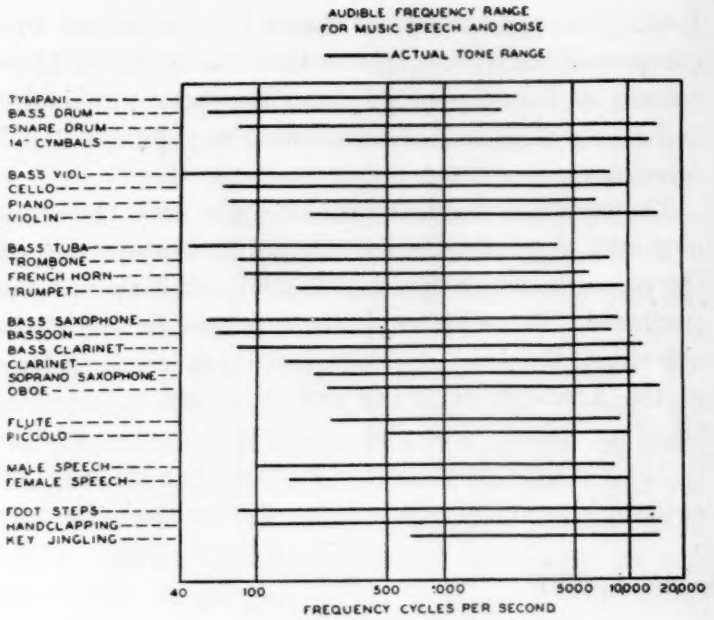

FIG. 2

and key-jingling, all of which are substantially near the upper limit of audible frequency for the average human ear.

TRANSMISSION LINES

The general route of the transmission lines, together with the location of the repeater or amplifier stations, is shown on Fig. 3. The distance between Philadelphia and Washington is approximately 140 miles and the transmission circuits are in lead-covered underground cable.

This figure also shows in schematic form the three separate channels required for the system just described. It also shows in rough schematic the energy level variations along the line. As will be seen, the energy amplification at each repeater station is about 50 db. In other words, at each repeater station the gradually weakened currents are enormously magnified to the end that the level of energy, as it is delivered at Constitution Hall, will be substantially the same as that at the Academy of Music.

The transmission lines themselves have substantially flat characteristics ($\pm$ 1 db) over the entire frequency range from 40 cycles to 15,000 cycles per second.

Carrier transmission is employed between the tele

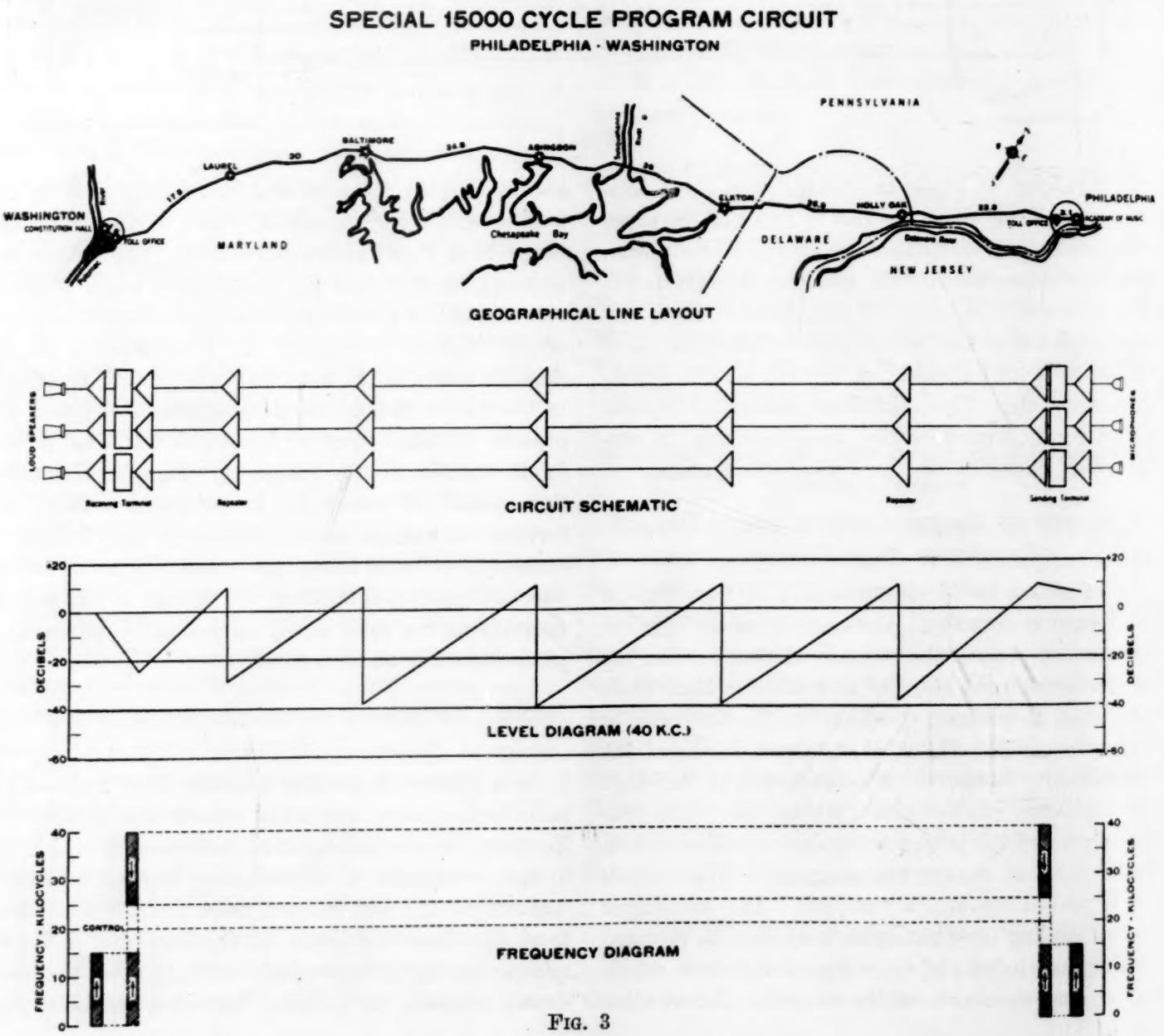

FIG. 3

phone toll offices in Philadelphia and Washington, a distance of approximately 140 miles. The carrier band lies in the frequency range between 25,000 and 40,000 cycles per second.

Fig. 4 shows a schematic of the special program circuit employed. As will be seen in this schematic and as will be referred to in a moment, accurate control of frequency and phase throughout the system and at its terminations is obtained by employing at the sending end a 20 kilocycle oscillator, part of whose output is transmitted over each of the three transmission channels. The 40 kilocycle carrier required for modulating at the transmitting end and for demodulating at the receiving end is obtained by employing a frequency doubling device at each terminal.

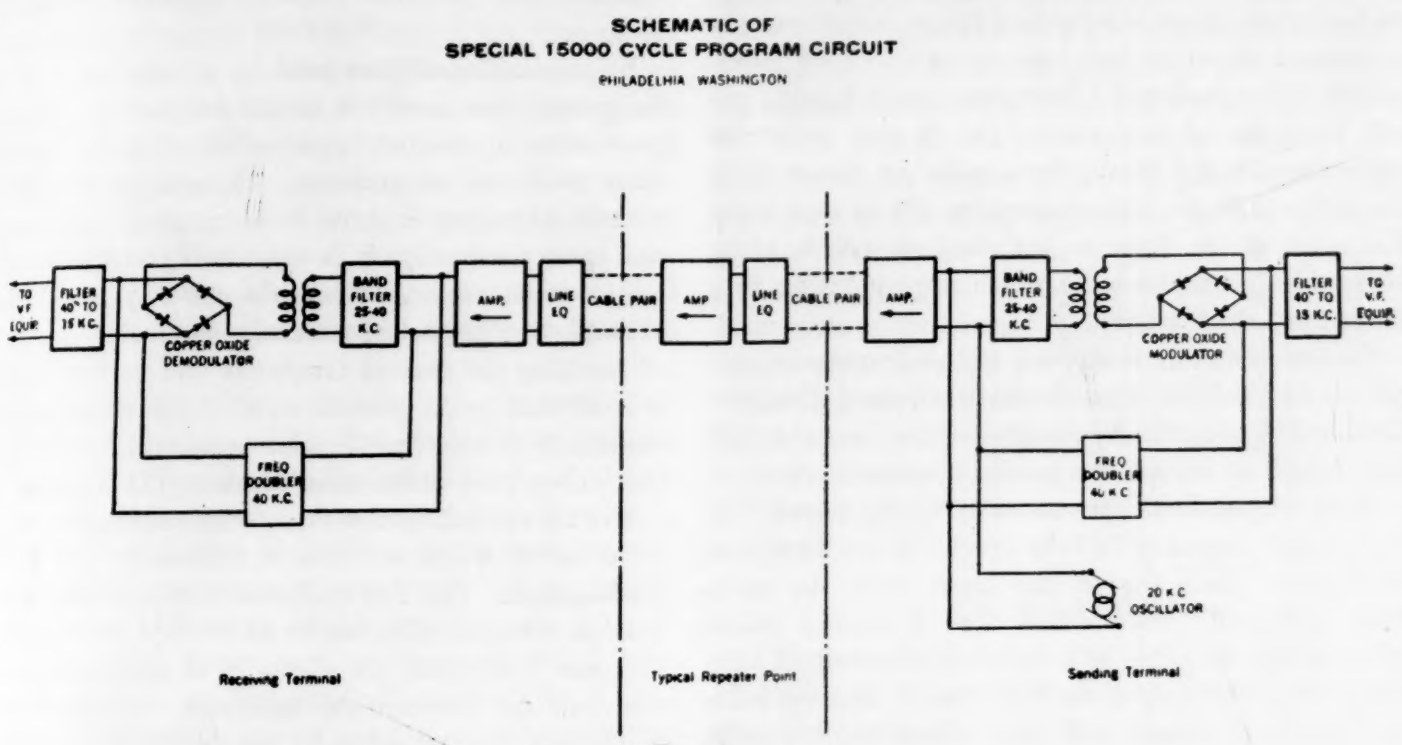

FIG. 4

LINE LAYOUT

Three 16-gauge (1.29 mm) non-loaded pairs in an underground toll cable between Philadelphia and Washington are employed. Spare circuits are provided. Normally, the telephone circuits operated through this cable require only two intermediate repeater points (Elkton and Baltimore). Because of the extra high frequency transmission required in this music reproduction, three additional points (Holly Oak, Delaware, Abingdon and Laurel, Maryland), have been established, located as shown between existing repeater points and the terminals.

REPEATERS OR AMPLIFIERS

Each repeater has been especially designed so as to be substantially free from distortion or non-linearity and very stable with respect to wide power variations. The gain at each repeater is about 50 db. An important feature at each repeater point are the equalizers to adjust the degree of amplification proportional to the line loss for the different frequencies. This is essential since, as is well known, the higher frequencies suffer a much greater attenuation during transmission over a cable circuit than do the lower frequencies. Without these equalizers enormous distortion would result.

One new repeater point (Holly Oak) is established in an existing telephone office. At two other points (Abingdon and Laurel) temporary huts have been erected to house the demonstration repeaters.

CARRIER APPARATUS

The carrier system employed is single sideband with the carrier frequency at 40 kilocycles and lower sideband transmission. In order, however, to obtain satisfactory transmission of the very low musical frequencies, what is known as "vestigial" sideband transmission is employed. This means that the unwanted (*i.e.*, upper) sideband is not entirely suppressed in the neighborhood of the carrier but is allowed to pass through the circuit to some extent so as to help out in the preservation of the low notes. This type of transmission circuit requires very careful attention to phase relations in filter design and accurate phase control of the carrier current which is supplied to the demodulator circuit in respect to that supplied to the modulator. As has already been mentioned, this is accomplished by transmitting some of the special control frequency of 20 kilocycles over each transmission

line, together with the music band. This transmitted 20 kilocycle control current is used at the receiving end by a frequency doubling device to supply the accurately phased carrier needed for demodulation.

NOISE

As has been referred to earlier, noise entering the transmission system is a limiting factor in determining the extent to which low level sounds can be transmitted and reproduced. Noise can reach a cable circuit in either of two ways. (a) It may enter the cable through the sheath from radio or power fields through which the cable passes, or (b) it may enter the cable at the ends or intermediate points along other circuits in the cable which are operating in a lower frequency range.

So far as (a) is concerned at the frequencies employed and for the transmission levels used, this particular Philadelphia-Washington cable is quiet and was found to require no special arrangements.

With respect to (b) the repeater layout is such that it was not necessary to take special steps, except at Baltimore. Here the volume levels from the north were sufficiently low so that high frequency noises produced in the office as a by-product chiefly of telegraph and switching operations passed into the cable over working circuits and cross-talked into the pairs used for the special broad band transmission. To prevent this the cable north was "isolated" from the office by putting choke coils in every pair in the cable. These choke coils are non-inductive to ordinary telephone or telegraph currents. They are inductive, however, to currents flowing over any of the conductor systems to ground.

LOCAL CIRCUITS

The carrier apparatus is located in the toll terminal offices at Philadelphia and Washington. Small gauge equalized underground cable circuits are used between the Academy of Music and the telephone office in Philadelphia and similarly at Washington between the telephone office and Constitution Hall.

AUXILIARY FEATURES

As has been previously mentioned, spare circuits are available in the cable to substitute in the event of any breakdown of the regularly assigned carrier pairs. Secondary spares of slightly lower frequency range capacity have also been provided in another cable to be available in the remote possibility of something happening to completely disrupt the cable carrying the regular circuits.

SUMMARY

In conclusion, all that need be pointed out is that the system just described is one designed for the reproduction in auditory perspective of symphonic or other music to an audience. Because of its multichannel character and its wide range of frequency and energy capacity, it is not readily adaptable for use in small rooms. While theoretically susceptible of employing any set of transmission channels capable of handling the desired frequency and volume range, it is at least in the present state of the art restricted essentially to wire transmission systems. This restriction arises from three main sources: (1) The ability to free the system against extraneous electrical or noise disturbances which at times so frequently mar radio transmission. (2) The uniformity with which transmission characteristics can be maintained and the relative ease with which the effects of attenuation can be overcome by intermediate repeaters. (3) The fact that under existing statutory regulation of radio it is impossible to secure clear channels of a frequency band requisite for the complete transmission of all the fundamental and overtone frequencies produced throughout the full range of musical instruments and the human voice.

Whether for local or distance use, the easily controlled and very tremendous volume ranges which the apparatus is capable of handling without distortion have placed in the hands of the musical director an implement for tonal effects not hitherto attainable. What the future use of the system in all its parts is likely to be will depend in large measure not only on the extent to which it is desirable to produce perfect music in auditory perspective at a distance remote from the source but likewise on the extent to which musical composers and directors find it effective in producing artistic effects beyond the capacity of the largest orchestras or choruses.

OBITUARY

ARTHUR HOLLICK
1857–1933

DR. (CHARLES) ARTHUR HOLLICK was born in 1857, the son of Frederick and Eleanor Eliza (Bailey) Hollick. He graduated from the Columbia School of Mines, 1879, and from the George Washington University in 1897 with the doctor's degree. He married Adeline Augusta Talkington in 1881. Although scientifically he was a paleobotanist of distinction, he filled many public offices, since he was a man of wide human interests. He was a member of the City of New York Board of Health from 1883 to 1893, a

member of the New York State Board of Education from 1907 to 1910, and of many local public services during the whole course of his life.

His academic positions were as follows: Tutor and fellow of Columbia University in geology, 1890–1900; curator of fossil botany, Columbia University, 1900–13; honorary curator, 1914–21; paleobotanist, New York Botanical Garden, 1921 to the time of his death; geologist to the United States Geological Survey; director of the Board of Education of New York City, 1907–10. He belonged to a large number of scientific organizations, including the New York Academy of Sciences, the Torrey Botanical Club, the Staten Island Institute of Arts and Sciences, the Geological Society of America, the Paleobotanical Society of America, the Botanical Society of America, etc.

His main scientific activities were in connection with fossil plants, and his first contribution was the editing of "The Later Extinct Floras of North America," left in form of notes by J. S. Newberry. He published during his active years a large number of papers on paleobotany, covering the Mesozoic and later floras. His most notable contributions were on the Cretaceous floras of New England, which were summarized as an important Memoir of the United States Geological Survey. Another extremely important and indeed classic contribution was on "The Fossil Flora of Alaska," which appeared a short time before his death. Not only was he the author of innumerable papers on fossil plants, but he acted officially in the paleobotanical publications of Puerto Rico, Louisiana, Maryland, New Jersey, New York State Museum and the Dominion of Canada. He was likewise a contributor to several general works, including the articles on paleobotany and fossil plants in the new International Cyclopaedia and also the Encyclopaedia Americana.

Hollick was a singularly lovable man and it was a great pleasure to make visits to the field in his company. The present writer recalls the happy days spent in this way on Staten Island, Long Island, Martha's Vineyard, the coast of New Jersey, etc. He was an indefatigable collector and was physically almost tireless. He would walk for hours through mud and rain and other discomforts in search of new discoveries in his favorite field. A not infrequent experience in paleobotanical excursions is dirt and discomfort (including parasites). These he endured most philosophically and the tedium which invariably arose at times was relieved from the rich store of his experiences. His last excursion was in Cuba, where he rode many hundreds of miles on horseback in the company of a good Spanish officer of the Church, who was at the same time a geologist. He returned from this last excursion apparently in the best of health, but unfortunately soon developed a malignant malady which was unsuccessfully operated on, and he passed away with traumatic pneumonia.

Dr. Hollick has left an enduring mark on American paleobotany, and particularly his works on the fossil floras of New England and Alaska will long stand as classic contributions to the subject. It has been for years a deplorable fact that too little interest has been devoted to the important subject of fossil plants in the United States. The older generation was passing and there were almost no promising successors. Fortunately at the present time this tendency has been corrected, and now a considerable number of young men of ability are taking up the study of extinct plants. In spite of the prevailing mechanistic tendencies of the hour, it is indubitable that paleontology occupies the same position on the intellectual side of biology that the ancient classics do in literature. There seems to be no doubt that the depth and background furnished by the study of extinct forms is an invaluable preparation for biological studies of any kind.

E. C. JEFFREY

MEMORIALS

A FRIEND of the late Olive M. Lammert, formerly professor of chemistry at Vassar College, has given $4,000 to establish the Olive M. Lammert fund to further the work in physical chemistry, and $1,000 for additional equipment in the precision laboratory, in which this work is carried on. The rooms in the Sanders Laboratory set aside for this field of study will be designated the Olive M. Lammert Laboratories.

AT a memorial meeting for the late Professor William Henry Holmes, held in the National Museum on April 22, the following resolution was passed:

WHEREAS: Notice of the passing of our colleague and friend, Professor William Henry Holmes, which occurred at Royal Oak, Michigan, on April 20, 1933, has been received with deep sorrow by members of the Smithsonian Institution and his other associates and friends; be it

Resolved: That we, assembled here to do honor to him, offer our tributes to this eminent man of science in whom the various phases of both art and science were fused to a degree seldom given in one man. Art, science and technic were the agencies he applied to the elucidation of his favorite science, anthropology. His passion for pure art is seen in his paintings which are poetical transcriptions of nature, not only portraying nature but revealing his inmost soul;

That his scientific writings and explorations form permanent contributions to the sum of human knowledge;

That we here record our sense of loss at the passing of Professor Holmes and extend to his family our sympathy in their sorrow.

ACCORDING to the London *Times* the hundredth anniversary of the death of Richard Trevithick, the

pioneer of the steam locomotive, on April 22, 1833, was celebrated on that day by a demonstration in Camborne, Cornwall. On April 23 a memorial service took place at 11 A.M. in the parish church of Dartford, Kent, where Trevithick died. The service was conducted by the vicar, the Rev. Elliott Mitchell, and the preacher was the Bishop of Rochester. An address on "The Life and Work of Richard Trevithick" was given by L. St. L. Pendred, past president of the Institution of Mechanical Engineers, and a chaplet was deposited at the foot of the Trevithick Memorial Tablet. At a service in Westminster Abbey special mention of the great engineer was made by the Archdeacon of Westminster in his sermon and a chaplet was placed below the Trevithick Memorial Window in the North Aisle. A memorial service was also held at Tregajorran Methodist Chapel, near Carn Brea, Cornwall. The chapel is on the site of Trevithick's birthplace. On April 24 a memorial lecture was delivered at the Institution of Civil Engineers by Professor C. E. Inglis. Sir Murdock MacDonald, president of the institution and chairman of the executive committee of the commemoration, presided.

RECENT DEATHS

DR. WILLIAM OPHÜLS, professor of pathology and dean of the Stanford University Medical School, died on April 27. He was sixty-one years of age.

DR. HENRY SMITH MUNROE, formerly a professor of mining at Columbia University, from 1877 until he became emeritus in 1915, died on May 4. He was eighty-three years old.

DR. JERE WILLIAMS LORD, for thirty-one years clinical professor of dermatology at the Johns Hopkins Medical School and consulting dermatologist at the time of his death, has died at the age of sixty-nine years.

PROFESSOR ERNEST WILLIAM HOBSON, formerly Sadleirian professor of pure mathematics in the University of Cambridge, died on April 18, at the age of seventy-six years.

DR. GEORGE HERBERT PALMER, professor of philosophy at Harvard University from 1873 until he became professor emeritus in 1913, died in Cambridge on May 8, at the age of ninety-one years.

SCIENTIFIC EVENTS

REPRESENTATION OF MUSEUMS AT THE CENTURY OF PROGRESS EXPOSITION

MUSEUMS from coast to coast and in Canada are arranging, as reported in *Museum News,* to send representatives to the Chicago meeting of the American Association of Museums, June 12 to 14. Some museums at a distance which can not pay the traveling expenses for members of their staffs are granting a week's extra vacation with pay for attendance at the meeting; and one museum is allowing this extra week and a week of the regular vacation to be taken consecutively. From hotel headquarters comes a renewal of notice that reservations should be made before May 15 in order to secure the best rates.

Railroads are making special rates for visitors to Chicago and there are indications that still further inducements to the World's Fair will be available to travelers from certain quarters. Prospective delegates should make inquiry of local railroad agents. Under some circumstances round trips to Chicago may be made for only ten per cent. more than one way fares.

The program of the meeting, including the programs of ten sections, will occupy three days and will include sessions at the Chicago Historical Society, the Art Institute of Chicago, the Field Museum of Natural History and the Chicago Academy of Sciences. Most of those attending will spend some days before or after the meeting in visiting the other museums of Chicago and the World's Fair. There is the Adler Planetarium and Astronomical Museum and the Shedd Aquarium, both with new buildings near the entrance to the exposition. *Museum News* calls attention to the fact that at the other end of the fair grounds is the new Chicago Museum of Science and Industry which will have in operation a coal mine in which 5,000 people daily may witness an unparalleled venture in realistic museum exhibition, including the illusion of a drop down a shaft and miles of travel underground past moving curtains. There is also the Oriental Institute Museum with its new building. The Century of Progress Exposition will have museum features—in its science building and elsewhere—which will be worth observing also.

Probably the greatest loan exhibition of art ever shown in America will be on display at the Art Institute of Chicago, which has been commissioned to assemble the official art exhibition of the World's Fair. The Art Institute is preparing a 300-page catalogue of the exhibition.

DEATHS FROM ASPHYXIATION

As a first step in a nation-wide educational program designed to reduce the number of avoidable deaths from the various forms of asphyxiation, an all-day state conference on the problem will be held on May 24, at the New York Academy of Medicine. Dr. Chevalier Jackson is chairman of the medical ad-

visory board of the Society for the Prevention of Asphyxial Death, which is calling the conference. The meeting will be held under the auspices of the public health relations committee of the New York Academy of Medicine.

The morning session will include an address by Dr. Shirley W. Wynne, commissioner of health of the City of New York, on vital statistics relating to asphyxia, with Dr. Haven Emerson, of Columbia University, opening the discussion; Dr. Harrison P. Martland, medical examiner of Essex County, New Jersey, will present medical examiners' findings in asphyxial cases, with discussion opened by Dr. Thomas A. Gonzales, deputy chief medical examiner of New York City; Albert W. Whitney, associate general manager of the National Bureau of Casualty and Surety Underwriters, will speak on the economic aspects of asphyxial mortality, with discussion by Leon Senior, manager of the Compensation Insurance Rating Board; Chief Surgeon Daniel J. Donovan, of the New York City Police Department, will explain through motion pictures the first-aid resuscitation methods used by the department.

Dr. Chevalier Jackson, of Philadelphia, will open the afternoon session with a paper on the fundamentals of laryngoscopy as applied in resuscitation, with discussion led by Dr. Charles J. Imperatori, professor of laryngology at the New York Post-Graduate Medical School and Hospital; Dr. Yandell Henderson, professor of applied physiology at Yale University, will present the fundamentals of gas therapy as related to the use of oxygen and carbon dioxide in resuscitation, with discussion opened by Dr. Dayton J. Edwards, associate professor of physiology at Cornell Medical College.

Dr. Edmund B. Piper, professor of obstetrics, University of Pennsylvania Medical School, will show the practical application of laryngoscopy and gas therapy in the treatment of the asphyxiated, with discussion led by Dr. H. J. Stander, professor of obstetrics and gynecology at the Cornell Medical College; Dr. Pol. N. Coryllos, professor of clinical surgery at Cornell Medical College, will give the principles and practise of the negative pressure cabinet in the treatment of asphyxia; Dr. John F. McGrath, vice-president of the Society for the Prevention of Asphyxial Death, will suggest ways and means of applying the improved resuscitation principles to medical and hospital practise.

A report preliminary to the conference has been issued by the Society for the Prevention of Asphyxial Death, of which the directors are: Dr. Paluel J. Flagg, president; Dr. Cornelius J. Tyson, medical director, St. Vincent's Hospital; Dr. Joseph D. Kelley; Dr. John F. McGrath, of the New York Hospital-Cornell Medical Center, and Dr. George W. Cumbler, of the Neurological Institute of the Presbyterian Hospital-Columbia Medical Center.

The report calls attention to the "alarming and needless loss of life through neglect and improper treatment of asphyxial cases." More than 50,000 deaths from asphyxia, many of which are preventable, occur annually in the United States, with approximately 2,800 deaths occurring each year in New York City alone. The death rate from this cause in New York City is twice that from automobile accidents, eighteen times that from diphtheria and nearly forty times that from typhoid. Of the total of 5,579 infants stillborn in New York City in 1931, approximately one fourth may be classed as having been capable of response to resuscitation properly applied.

THE DEDICATION OF THE GEORGE EASTMAN LABORATORIES AT THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CHEMISTS and physicists gathered at the Massachusetts Institute of Technology on May 1 for the dedication of the great George Eastman Research Laboratories. President Karl T. Compton, of the institute, made the address of welcome to a large gathering of official delegates from scientific and engineering organizations and various educational institutions in this country and abroad.

In an address on "Science at the Massachusetts Institute of Technology," Dr. Samuel C. Prescott, dean of science, reviewed the contributions of the institute to the progress of science and commented upon its present status and prospects for the future.

Dr. Harry M. Goodwin, dean of the Graduate School, discussed the field of advanced education at the institute, while Dr. Frederick G. Keyes, head of the department of chemistry, discussed the significance of chemistry. The address of Dr. John C. Slater, head of the department of physics, described education and research in physics.

Following the morning meeting, which was held in the main lecture hall of the new building, there was an inspection of the various laboratories of physics and chemistry, followed by a luncheon.

The exercises included the dedication of a tablet at the entrance to the present Rogers Laboratory of Physics, commemorating the establishment in 1869 by William Barton Rogers, founder of the institute, of the first physical laboratory for purposes of instruction.

Many of the official delegates to the dedication, representing scientific societies and educational institutions, attended a reunion dinner of the Research Laboratory of Physical Chemistry in the Forris Jewett Moore Room. The dinner was given in honor of Dr.

Arthur A. Noyes, founder of the laboratory and acting president of the institute from 1907 to 1909, now director of the Gates Chemical Laboratory at the California Institute of Technology.

The program in the afternoon included a meeting at which Dr. Arthur H. Compton, of the University of Chicago, described the latest work on the origin and nature of the cosmic rays. At this meeting Dr. Charles A. Kraus, professor of chemistry at Brown University, made an address on "Thirty Years of Physical Chemistry."

At the conclusion of the afternoon meeting the inspection of laboratories was resumed, after which the visitors attended a tea in the Forris Jewett Moore Room. In the evening they were the guests at a private dinner in Walker Memorial, and later attended a reception by President Compton and members of the staff of the new laboratories.

PROFESSOR EINSTEIN

AS SCIENCE has reported, the French Government has offered its hospitality to Professor Einstein, and for this purpose has created a chair of mathematical physics at the College of France. This has been offered to Professor Einstein, who has accepted the call.

The London *Times* states that the creation of this new chair required legislation, and a bill was hastily prepared by the Ministry of Education. It was introduced into the Chamber by M. de Monzie, the responsible minister, and was rapidly passed through all the necessary stages before the deputies separated for the recess.

In the preamble to the bill M. de Monzie recalled as a precedent the action of the French Government in 1840 in creating a Chair of Slavonic Literature for the Polish poet Adam Mieckiewicz, then in exile, and declared that the Third Republic should show itself to be at least as liberal as the July Monarchy. The chair was destined for the occupation of a foreign *savant* who would find in the foundation of Francis I. the spiritual liberty and serenity necessary to his labors and the welcome due to his genius.

At the close of a brief discussion of the measure in the Chamber M. Daladier asked the deputies to associate themselves with the government in passing the bill and thus honor not only a man of genius but a man of courage. The measure was unanimously adopted.

Professor Einstein has addressed the following open letter to the Prussian Academy of Sciences, from which he recently resigned:

I have received from absolutely reliable sources the report that the Academy of Sciences, in an official declaration, spoke of the "participation of Albert Einstein in the atrocity campaign in America and France."

I hereby declare that I have never taken part in any atrocity campaign, and I must add that I have seen nothing whatsoever of such a campaign. In the vast majority of cases people contented themselves with repeating and commenting upon official declarations and decrees of responsible persons in the German Government as well as the program for the economic destruction of the German Jews.

The information I have given to the press was that I would resign my position in the academy and surrender my rights of German citizenship; I gave as my reason the fact that I did not want to live in a country where equality before the law and freedom of speech and of teaching were not granted to the individual.

In addition I explained the state of present-day Germany as one of psychic illness in the masses and said something about the causes. In an article which I gave for circulation purposes to the International League for Combating Anti-Semitism, and which was in no way intended for the press, I further summoned all thoughtful people who remain true to the ideals of a threatened civilization to do everything possible to prevent this mass psychosis, which had manifested itself in such an appalling way in Germany, from spreading further.

It would not have been difficult for the academy to have acquired a proper text of my statements before talking about me in the way it has done. The German press has misrepresented my statements in a tendentious manner, as is only to be expected in view of the present gagging of the press.

I stand by every word I have uttered. But I expect in return that the academy—particularly as it has contributed to my defamation before the German public—should put this statement of mine before its members and the German public before whom I was calumniated.

SCIENTIFIC NOTES AND NEWS

DR. JAMES B. CONANT, Sheldon Emery professor of organic chemistry, was on May 8 elected president of Harvard University by the corporation to succeed Dr. A. Lawrence Lowell.

AT a meeting of the board of trustees of the American Museum of Natural History on May 1, a resolution was adopted directing that the hall which houses the collection of the Pleistocene period be known as the "Osborn Hall of the Age of Man," in recognition of Dr. Osborn's "untiring devotion to vertebrate paleontology." At this meeting a portrait of Dr. Osborn by Mr. Julian Lamar was presented to the museum by the trustees.

DR. MAX PLANCK, professor of physics in the University of Berlin, celebrated his seventy-fifth birthday on April 23.

PROFESSOR D'ARSONVAL recently retired from the chair of physiology at the Collège de France on the occasion of his eighty-first birthday.

THE Berlin correspondent of the *Journal* of the American Medical Association writes: "The recognized leader among German pharmacists, Professor Hans Horst Meyer, of Vienna, celebrated his eightieth birthday, March 17. At the age of twenty-nine he held the chair of pharmacology at the University of Dorpat, Estonia. From Dorpat he was called to Marburg; in 1904 he was given the chair of pharmacology at Vienna, and, refusing a call to Berlin, he held this position until he reached the age of enforced retirement. On his seventieth birthday, the Vienna Academy of Sciences established the Hans Horst Meyer prize, which is bestowed every five years for the best research in the German language in the field of experimental medicine."

ON the occasion of the celebration of a half-century of progress in dentistry at the University of Pennsylvania on May 8 the honorary degree of doctor of science was conferred on Dr. Herbert S. Jennings, director of the zoological laboratory of the Johns Hopkins University; Dr. Milo Hellman, professor of orthodontia at Columbia University and research associate of the American Museum of Natural History; Dr. Leroy Matthew Simpson Miner, dean of the Harvard Lental School, and Dr. Charles Root Turner, dean of the Dental School of the University of Pennsylvania. The doctorate of laws was conferred on Dr. Samuel P. Capen, chancellor of the University of Buffalo. Addresses were made by Professor Herbert S. Jennings on "The Biologist's Outlook on the World" and by Surgeon-General Hugh S. Cumming, U. S. Public Health Service, on "The Relationship of Dentistry to Public Health." At the annual dinner addresses were made on "The Field of Dentistry," by Dr. Leroy M. S. Miner; on "Dental Education," by Dr. Samuel P. Capen, and on "The Dental School in the University," by Dr. Thomas S. Gates, president of the University of Pennsylvania.

THE Mendel Medal, awarded annually by Villanova College to "a Catholic who has achieved distinction in the advancement of the sciences," was presented on May 4 to Dr. Hugh S. Taylor, David B. Jones professor of chemistry and chairman of the department of chemistry at Princeton University. Rev. Edward V. Stanford, president of the college, made the presentation.

FELIX M. WARBURG has resigned as a member of the board of trustees of the American Museum of Natural History after a membership of twenty-three years. The vacancy has been filled by the election of Mr. Warburg's son, Frederick M. Warburg. John D. Rockefeller, 3rd, has been elected to succeed Frederick E. Brewster, who resigned in January after serving for twenty years.

PROFESSOR J. T. J. MORRISON, on his retirement from the chair of forensic medicine and toxicology at the University of Birmingham, has been elected by the Court of Governors emeritus professor and a life governor of the university.

DR. BENNO E. LISCHER, professor of orthodontics in the University of California, has been appointed dean of the School of Dentistry, Washington University, St. Louis.

DR. SOLOMON LEFSCHETZ, professor of mathematics at Princeton University, has been appointed to the Henry Burchard Fine chair of mathematics to succeed Professor Oswald Veblen, now a member of the faculty of the Institute for Advanced Study.

DR. HENRY MCE. KNOWER, research fellow in the Osborn Zoological Laboratory at Yale University, has been appointed research associate in biology with the rank of associate professor.

DR. S. F. HILDEBRAND, senior ichthyologist of the U. S. Bureau of Fisheries, has been "loaned" to Mississippi to make investigations on which to base a scientific program for fish conservation and propagation in Mississippi, following representations to the bureau from the State Fish and Game Commission and the congressional delegation of that state asking for assistance in securing information on spawning seasons of the various fish.

DR. GEORGE M. SUTTON, curator of birds at Cornell University, has left for the Chisos Mountains in the Big Bend Region of Texas, on a joint Cornell-Carnegie Institution bird-hunting expedition.

NEW officers of the Western Reserve University Chapter of Sigma Xi include: Dr. Harold S. Booth, associate professor of chemistry, *president;* Dr. James Angus Doull, professor of public health, *vice-president;* Dr. Wilton Marion Krogman, associate professor of physical anthropology, *secretary;* Dr. Amos Henry Hersh, assistant professor of biology, *treasurer;* Dr. Webster G. Simon, professor of mathematics, and Dr. Bradley M. Patten, associate professor of histology and embryology, *members of the nominating committee.*

AT the annual meeting of the Boston Society of Natural History, held on May 3, the following officers were elected for 1933–1934: *President,* Charles H. Taylor; *Vice-presidents,* Nathaniel T. Kidder, Glover M. Allen, William M. Wheeler; *Secretary,* Clinton V. MacCoy; *Treasurer,* Augustus P. Loring, Jr.; *Trustees,* Thomas Barbour, John A. Blanchard, William

L. W. Field, Ralph Hornblower, Frederic H. Kennard, John C. Phillips. At the same meeting the annual Walker Prizes in Natural History, offered this year for the best memoir on any subject in the field of botany, were awarded to Lyman B. Smith, of Harvard University, for his paper on "Evolutionary Lines in the Bromeliaceae," and to George Hume Smith, of Indianapolis, for his paper on the "Anatomy of the Embryonic Leaf." Alice A. Mackenzie, of Pittsburgh, Pennsylvania, received honorable mention for her paper entitled "A Few Observations on Adaptations for Support Exhibited by Plants."

THE Board of Directors of the Bache Fund, composed of Professors E. B. Wilson, W. J. V. Osterhout and Heber D. Curtis, chairman, at their meeting in Washington on April 26, made grants as follows: To Miss Cecilia H. Payne, Harvard College Observatory, Cambridge, Mass., for the determination of photographic magnitudes of southern stars; to Robert R. McMath, McMath-Hulbert Observatory, for motion picture researches on the solar prominences; to Dr. Graham Edwards, School of Medicine, University of Buffalo, for renal researches; to Dr. O. J. Lee, Dearborn Observatory, for investigation of the spectra of faint stars; to Dr. J. Elery Becker, Iowa State College, for researches on the protozoal parasites of ground squirrels; to Dr. Michael Heidelberger, Presbyterian Hospital, New York, for the purchase of an interferometer for the study of precipitin reactions.

DR. JOYCE CLENNAM STEARNS, professor of physics and mathematics at the University of Denver, has been given a grant of $300 from the Carnegie Institution and another for the same amount from the Rumford Committee, which he will use for further study of the cosmic ray.

THE Secretary of Agriculture, Henry A. Wallace, spoke before the Franklin Institute, Philadelphia, on May 9, the title of his address being "Agriculture and Science." He described the present situation of the scientific departments of the government, as well as the relationship of science to agriculture.

DR. JOHN CAMPBELL MERRIAM, president of the Carnegie Institution, delivered a James Arthur Foundation lecture on May 4, entitled "Time and Change in History."

DR. GEORGE W. MCCOY, director of the National Institute of Health of the United States Public Health Service, delivered a public address on April 27, under the auspices of the Lehigh University Chapter of Sigma Xi, on "Our National Defense against Disease."

DEAN GEORGE F. KAY, head of the department of geology at the State University of Iowa, and state geologist of Iowa, lectured recently at the University of Rochester, Cornell University and Vassar College, on "Glaciation: the Background of Mississippi Valley Development."

DR. E. W. GOODPASTURE, professor of pathology, Vanderbilt University School of Medicine, gave the annual address of the LaFayette Guild chapter of the Gorgas Medical Society at the University of Alabama, on April 28. The subject of his address was "A Medical Pageant." Following the address, Dr. Goodpasture was made an honorary fellow of the Gorgas Medical Society.

DR. ALEXANDER PRIMROSE, formerly dean and professor of clinical surgery, University of Toronto Faculty of Medicine, Toronto, delivered the seventh annual Donald C. Balfour Lecture in Surgery at the university on April 5. Dr. Primrose's subject was "The Interrelation of Anatomy and Surgery." The day was the one hundred and sixth anniversary of the birth of Lister.

SIR FRANK DYSON, formerly astronomer royal of Great Britain, who has arrived at Capetown on a holiday in South Africa, addressed a meeting of the Astronomical Society of South Africa, giving a critical summary of the work of his predecessors at Greenwich.

ALL works of Dr. Franz Boas, professor of anthropology in Columbia University, have been removed from the library of the University of Kiel. The writings of Professor Boas are particularly distasteful to the Nazi, because of his opposition to the theory of "Nordic" or "Aryan" racial superiority which forms the basis of the National Socialist social philosophy. Professor Boas received the doctorate degree from Kiel in 1881 and was last year given an honorary degree by the university.

AFTER a period of inactivity since 1918 the Arkansas Academy of Sciences held its annual meeting in Little Rock on April 14 and 15. The academy was organized and chartered by the state in 1917 and was active into 1918, but because of the war, activities were suspended until last fall when the organization was revived. The following officers were elected: *President,* D. M. Moore, University of Arkansas; *Vice-president,* C. F. Allen, Little Rock; *Treasurer,* H. H. Schwardt, University of Arkansas; *Permanent Secretary,* L. M. Turner, University of Arkansas.

A GROUP of fifty-seven advanced and graduate students of the department of chemical engineering of the Ohio State University left Columbus on May 1,

on the twenty-seventh Annual Chemical Engineering (Eastern) Inspection Trip under the direction of Dr. James R. Withrow, chairman of the department, and Assistant Professor Joseph H. Koffolt. They planned to visit plants in Rittman, Barberton, Akron, Cleveland, Niagara Falls, N. Y., Rochester, New York City, Grasselli, New Jersey, Wilmington, Delaware, Baltimore, Maryland, and Pittsburgh, Pennsylvania. The industries visited included the paper board industry, rubber industry, chemical stoneware, dirigible fabrication, paints, varnishes, insulators, high tension problems, manufacture of tungsten filaments, glass bulb blowing, hydroelectric power development, carborundum, petroleum refining, heavy chemical manufacture, manufacture of graphite, rayon, electrolytic caustic soda, chlorine, glass-lined equipment, silver salts, photographic films, sugar refining, dyes, chemicals and intermediates, industrial alcohol, alcohol chemicals, the U. S. Bureau of Mines, Pittsburgh, and the Fuel Testing Laboratory of the Carnegie Institute of Technology, Pittsburgh.

GIFTS to the National Research Council since last October include three new appropriations from the Rockefeller Foundation: (*a*) A fund of $50,000 for the continuation of the general research aid fund which has been administered by the council since 1929, making a total of $320,000 provided by the foundation for this purpose. (*b*) A fund of $75,000 for the support of the program of research in problems of sex which has been directed by the council since 1922, with the aid of grants from the foundation now amounting to $735,000. (*c*) A further appropriation of $75,000 has been made by the foundation to *Biological Abstracts* for the expense of the editorial work of this journal. This fund will be administered through the National Research Council. Altogether a total of $793,000 has been provided by the foundation toward the support of the *Abstracts* since the establishment of the journal, which began publication in 1926. The firm of E. R. Squibb and Sons has given the sum of $1,400 for the support of two fellows working in cooperation with the Committee on Drug Addiction, one with the group engaged upon chemical investigations for the committee at the University of Virginia, and one with the group at the University of Michigan, which has charge of the physiological investigations of the committee.

THE late Dr. Alexander S. Monro, Vancouver, B. C., former president of the Canadian Medical Association, who died on August 12, 1932, bequeathed to the University of British Columbia a fund of $80,000 for medical research. The bequest will become available after the death of all beneficiaries of the will.

ACCORDING to the London *Times*, an official decree issued by the commissarial burgomaster of Munich, Herr Fiehler, restricts all Jewish doctors in the Munich municipal hospitals (including most of the university institutions) to Jewish bodies in their dissection work, and bans all Jewish medical students from these hospitals.

THE transmission of weather maps by teletype, over a mileage of airways which already amounts to about 13,000 miles, is a new feature introduced in the weather service in the United States through a cooperative arrangement made between the Weather Bureau of this department and the Department of Commerce. Such transmission is a valuable improvement in the efficiency of weather service for air traffic of all kinds, says the Weather Bureau. For the purpose of the teletype distributing system the country is divided into three regions, for which Cleveland, Kansas City and Oakland, Calif., serve as distributing centers. At these centers Weather Bureau personnel prepare base weather maps every four hours for the respective regions. These base maps are then given to teletype operators of the Department of Commerce, who place them in a teletypewriter and type on them symbols representing ceiling, visibility, lines of equal barometric pressure, etc. The maps are sent over a number of electric circuits simultaneously by use of an automatic perforator and perforated tape. With the use of the perforated tape the map is duplicated at all teletype-equipped points in the circuits. After a map has been transmitted to the circuits in its own region it is then relayed to circuits in other regions.

DISCUSSION

DESTRUCTION OF MOORING ROPES BY TEREDO; GROWTH AND HABITS IN AN UNUSUAL ENVIRONMENT

IN the summer and autumn of 1930 a species of *Teredo* appeared in Long Island Sound in unprecedented numbers. Instead of confining their borings exclusively to piles and other submerged pieces of wood, as is usually the case, the young mollusks also attacked the ropes which held buoys and mooring floats at anchor. In a number of cases the ropes were entirely severed and the boats set adrift. The greatest damage seems to have occurred in New Haven Harbor, but similar trouble was reported from near New York. Mr. Raymond E. Miskelly, of the Plymouth Cordage Company, who first called my attention to this attack on rope, informs me that injuries of this nature were more or less general along the coast south of Cape Cod, as well as in Long Island Sound, during the same months.

The species responsible for this aberrant behavior

was identified by Dr. Paul Bartsch as *T. morsei* Bartsch,[1] which is always found in submerged timbers in these localities and which has been usually considered merely a local variety of the widely distributed *T. navalis* Linn. Although all the individuals in the ropes were young, the variations in structure of shell and shape of pallets fall within the limits found by Miller[2] to occur in *T. navalis* under various environmental conditions.

Only ropes that had been continuously submerged for several weeks were seriously damaged and these mainly at the lower ends near the attachments to the anchors, corresponding with the usual preference of teredos for wood placed within about a meter above the surface of the mud.[3,4] In the rope, however, the damage usually extends for two meters or more, due to the slack which falls to the bottom at low tide.

The habits of the young mollusks in the rope are somewhat different from those of other individuals when boring in wood. The fibers of the rope are all twisted into close spirals in the yarns of which the rope is composed and the yarns are again twisted spirally into the cords which are themselves twisted into the finished rope. The *Teredo* in boring tends to penetrate at right angles to the surface, but, due to the twist of the fibers, the tunnel actually cuts obliquely across the yarn. The diameter of the yarn is frequently between 2 and 4 mm and as soon as the tunnel approximates this diameter the yarn is completely severed. The individual fibers of the rope are thus cut into bits, ranging from a few millimeters to a few inches in length, according to the distance between adjacent borings. When the borings are close together the affected portion of the rope falls into shreds. The parting of the fibers leads to the death of all the borers, which drop out into the water.

It has been observed[3] that the *Teredo* seldom passes from one piece of wood to another closely applied, but in the rope many of the tunnels lead from one yarn to the next.

The young mollusks had evidently found the ropes less suitable than wood for normal growth, for many of them were approaching sexual maturity when only 10 to 12 mm in length. In wood the size at sexual maturity may reach 40 to 50 mm if conditions are favorable; otherwise growth may be retarded while the development of sexual products continues, but more slowly than in individuals growing in a more favorable environment.

Examination of the gonads of many of these young teredos shows that in this unusual situation there is a strong tendency toward protandric bisexuality. In approximately half the sexually differentiated individuals studied the gonads consisted of a cortical layer of yolk-forming ovocytes, with spermatogenic cells filling the lumen of each follicle. There was a fairly close correlation between the size of the ovocytes and the abundance of spermatozoa already formed, indicating a typical protandric condition. In a few individuals most of the spermatozoa had been previously discharged and in these the ova were fully mature. Some evidence of protandry has been reported for another species of the genus.[5]

In addition to the protandric females other individuals were presumably exclusively male, the cells of the cortical layer remaining small and apparently undifferentiated. Others had only a few scattered ovocytes in the cortical layer of an otherwise typical spermary. Thus all individuals first function as males, at least in this unusual environment.

The fibers of the rope are devoured and partially digested, as is normally the case with wood,[6] but the animals remain stunted and produce but few gametes as compared with the vast numbers formed by normal individuals.

Even if a certain amount of reproduction does occur by the teredos living in the rope, this material is highly unsuitable for long survival, and the mortality before reaching the reproductive period must be very great. If the borers are numerous the cut fibers of the rope separate or the entire rope parts; in either case the adjacent borers perish by being dropped out into the water.

While the damage reported in 1930 was unusually serious, these are not the only records of teredos boring in rope or in plant structures other than wood. Lobstermen state that they experience trouble of this nature from time to time, as the borers attack not only the wooden trap but the adjacent part of the buoy rope as well. The unprecedented abundance of this mollusk in that year is thought to have resulted from unusually favorable conditions for the survival of the larvae, which float for two to three weeks[3,4] near the surface of the water before settling upon the objects in which they bore and mature. The free-swimming stage is always precarious and most of the larvae die without completing metamorphosis. Their potential numbers are exceedingly large, however, for a single female may produce more than a million larvae in one season.[3,4] The conditions for survival were evidently better in 1930 than in any other recent year and this is true not only for the teredo but for

[1] Paul Bartsch, *Bull. 122, U. S. Nat. Mus.*, 1922.

[2] R. C. Miller, *Univ. Calif. Publ. Zool.*, 22: 292–328; 401–414, 1922–23.

[3] H. B. Grave, *Biol. Bull.*, 55: 260–282, 1928.

[4] C. A. Kofoid and R. C. Miller, *Final Rept. San Francisco Bay Marine Piling Comm.*, 188–343, 1927.

[5] C. M. Yonge, *Quart. Jour. Mic. Sci.*, 70: 391–394, 1926.

[6] C. M. Yonge, *Trans. Roy. Soc. Edinburgh*, 54: 703–718, 1926.

other mollusks, such as the oyster and clams, which have similar free-swimming larvae, for these survived in unusual numbers the same year.

The presence of even a few adult teredos in piling or in other submerged wooden structures may thus lead to a repetition of this unusual behavior whenever the environmental conditions are such as to favor the survival of their innumerable progeny, provided there is not sufficient wood in the areas to which the pelagic larvae are carried by the currents in the water.

W. R. COE

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THE EFFECTS OF MEDIA ON BACTERIAL FILTRABILITY

THE fact that Seastone and Lawrence[1] were unable to duplicate Kendall's filtration experiments on the Rawlins strain of *B. typhosus*, even with "K" medium made from "K" powder supplied by him, indicates the probable existence, in this work, of one or more neglected but variable factors. This is further evidenced by the statement of Seastone and Lawrence that their "K" medium showed no uniformity of pH from tube to tube, and also that it occasionally developed a spontaneous turbidity without inoculation.

I query whether bacteriologists, in carrying out filtration experiments, consider or give due weight to the following physico-chemical or colloid factors operative in their media, even when using identical filters; for variations in the filters themselves involve a series of additional factors, based on the specific attractions between filter constituents, bacteria and media constituents:

(1) Colloids may favor the passage of fine particles through filters.
(2) Variation in bacterial deformability may affect filtrability.
(3) The flocculative or deflocculative power of the medium, at the time of filtration, must be considered.

At a symposium on filtration held by the American Society of Bacteriologists at Philadelphia in December, 1926, I heard no reference to factors (1) and (2), and felt constrained to draw attention to them in the open discussion and later on in SCIENCE for February 25, 1927.

Factor (1) was dealt with by R. Zsigmondy ("Colloids and the Uultramicroscope" [1909], Chapter 14 on Filtration Experiments), and the fact that moistening the gut with bile increases its permeability to some products of digestion is known to physiologists. Factor (2) was pointed out by Bechhold and Neuschloss,[2] in connection with work on lecithin emulsions where the individual droplets, several μ in diameter, under a pressure above 150 g./cm^2, passed through an ultrafilter which completely retained hemoglobin, and whose pores were less than 30 mμ in diameter. Bechhold's explanation is that the lecithin passes the filter-pores in filiform fashion, and reforms droplets after its exit.[3] Apart from the stage of growth of the inoculum, and the relative growth-producing quality of the medium for the bacteria, both of which affect bacterial size, it is not impossible that changes in the medium (and pH is only one factor) may affect the *turgidity* of the bacteria present, and therefore their filtrability under constant pressure.

As to factor (3), the protective or coagulative action of any medium is the summation of various factors, including the specific colloids present. Filtration conditions are affected by pH, salts, temperature, cumulative protective relations, etc. There is an extensive literature on the wide variation in the protective action of colloids, especially of albumins, albumoses and their fractions, toward colloidal gold ("gold number"). Some fractions, instead of being protectors, are active coagulators.[4]

On first reading of Kendall's results,[5] it seemed possible that they might, in part, be accounted for by some or all of the factors above stated. Through the kindness of Dr. L. W. Famulener and his staff at the Pathological Laboratory of St. Luke's Hospital (New York), I was able to have made some preliminary tests on the relative protective behavior of three bacterial media, obtained through courtesy of the New York City Board of Health.

On March 24, 1932, samples of beef broth, veal broth and "K" medium were subjected to the "colloidal gold reaction," according to the technique described by Karl M. Vogel.[6]

The results were:

Beef broth	5	5	0	0	0	0	0	0	0	0
Veal broth	0	0	0	0	0	0	0	0	0	0
"K" medium	0	0	0	0	0	½	1	2	2	1

Here 0 represents satisfactory protection, 5 represents complete coagulation and precipitation of the gold, and the intermediate numbers represent varying degrees of aggregation of the gold ultramicrons. The figures in the first column are for the original concentrations; those in subsequent columns are the results for progressively doubled dilutions.

[1] SCIENCE, 77: 259, 1933.

[2] *Kolloid Zeitschrift*, 1921.

[3] H. Bechhold, "Colloids in Biology and Medicine," 1920.

[4] Zsigmondy, *lib. cit.*, pp. 79–89.

[5] SCIENCE, 75: 295–301, 1932.

[6] *Arch. Int. Med.*, 22: 496–516, 1918.

While these results are no criterion for the protective action of media wherein bacteria have grown, towards these same bacteria, they do indicate that media may exhibit wide differences in "gold number," which often parallels protective and deflocculative action, as well as the ability to aid the passage of particles through filters. Thus, Hans Zinsser[7] reported that Ward and Tang, in his laboratory, found that the agents of vaccine and herpes would pass through a filter more readily when suspended in certain types of broth than when suspended in isotonic salt solutions, irrespective of pH; further, that Grinnell found that *B. prodigiosus* passed through all their "V" Berkefeld and Mandler filters, and through most of grade "N," if taken from old cultures and suspended in hormone broth of about pH 7.8.

Speaking of filtrable viruses, T. M. Rivers stated:[8] "Methods of filtration are crude and inaccurate, and the most any one can say concerning viruses is that under given experimental conditions they either pass or do not pass through certain filters. The failure to pass through a filter, however, is certainly not determined in every instance by the size of the virus."[8]

There are, no doubt, many other factors to be considered, besides the three above suggested. Thus, discrete particles in the medium might adsorb otherwise filtrable particles; or oppositely charged particles might form with bacteria a non-filtrable coagulum or union. As pointed out by May Annetts,[9] changes in conductivity, pH and stability may be expected to accompany the filtration of suspensoid sols. Filters described as "certain" may prove to be very uncertain, under special conditions. There is a wide call for bacteriologists, suitably equipped, to give proper recognition and evaluation to all these physicochemical factors, while attempting to establish exact technique for reproducible filtration experiments.

JEROME ALEXANDER

NEW YORK, N. Y.

A TEST FOR THE PRESENCE OF NOVOCAINE IN NERVOUS TISSUE

DURING the course of some research work upon spinal anesthesia, it became desirable to determine the degree of penetration of novocaine solution into the substance of the spinal nerve roots, spinal cord and medulla, when injected into the subarachnoid space of live animals. At first we attempted to follow the course of the novocaine by adding a dye (methylene blue) to the novocaine solution and checking the distribution of the color post-mortem. The dye was effective in coloring the surface of the nervous tissue and membranes but, on section, none was found within the substance of the nervous tissue. If the extension of the dye were an indication of the extension of the novocaine itself, the failure of the color to penetrate the nervous substance was not in accord with the production of anesthesia and, in some cases, the death of the animal. That the novocaine penetrated further into the nervous tissue than the dye with which it was in solution was the inevitable conclusion. To obtain direct evidence of this as well as to determine the exact distribution within the nervous tissue, a method of recognizing novocaine within the substance of the latter was sought. It occurred to one of us (Beber) that the novocaine might be diazotized, and a color reaction obtained with beta naphthol.

The method evolved is briefly as follows: The nervous tissue to be tested is placed in a beaker of cold 5 per cent. sodium nitrite solution. After a few minutes hydrochloric acid (1:10) is added in the proportion of one of the latter to five of the former solution. This liberates nitrous acid, which in turn diazotizes the novocaine. It is essential that the solution be kept cold for this reaction. After five minutes, the specimens are washed in distilled water and transferred to a 5 per cent. alcoholic solution of beta naphthol. The tissue containing novocaine takes on an orange red color which is greatly intensified by transferring to a weak solution (2 per cent.) of sodium hydroxide. The color fades if placed in water or carried through the usual solutions used in preparing paraffin sections. For section work it is found best after bringing out the color reaction to fix the tissue in 10 to 20 per cent. formalin for fifteen to twenty minutes, freeze and cut thick (fifty μ).

Control experiments, in which the nervous tissue was either treated with distilled water instead of novocaine or not treated at all, failed to produce a similar color reaction when subjected to the same process.

MANUEL GRODINSKY
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SPONGE SPICULES FROM THE LOWER ORDOVICIAN OF WISCONSIN

WHILE examining insoluble residues from the Oneota dolomite (Lower Ordovician) of Wisconsin the writer came upon numerous detached sponge spicules from one locality. The location in question is on U. S. Highway 12, about three or four miles south of Springfield Corners, Wisconsin. Although the writer has examined several hundred samples of the Oneota from numerous localities in the Upper

[7] SCIENCE, 75: 257, 1932.

[8] Jordan and Falk, "The Newer Knowledge in Bacteriology and Immunology" (1927), p. 519; see also S. P. Kraemer, *ibid.*, 557.

[9] *Phys. Chem.*, 36: 2939, 1932.

Mississippi Valley, no sponge remains have been observed elsewhere.

The Oneota near Springfield Corners is a medium to thick bedded dolomite, having a gray or flesh color and carrying a few lenses and thin beds of chert. The sample yielding the spicules is from a pure, non-cherty bed, the insoluble residue consisting of a minute quantity of very fine sand, silt and sponge spicules.

Under the microscope the spicules are seen to be composed of amorphous silica, with considerable amounts of crystalline silica. In form they are uniaxial needles, sharpened at each end, and show no evidence of having been fused in the organism. The longest one observed measures 0.41 mm in length and 0.02 mm in diameter. Axial canals in the spicules can not be plainly seen, but there is a suggestion that they were present in life. It is believed, therefore, that the spicules are to be classified as Silicispongia, order Monactinellida Zittel.

The fauna of the Oneota is a meager one, and nearly all the forms found have been in the chert nodules. These sponge spicules may be the first sponge remains reported from the Oneota formation, as the writer has found no mention of them in the available literature describing these rocks. It is stated by Zittel[1] and Berry[2] that Monactinellid spicules are known from rocks as old as Silurian. No mention is made of their occurrence below the Silurian. If the writer's identification is correct, the spicules from southern Wisconsin may be the oldest Monactinellid spicules thus far discovered.

C. E. NEEDHAM
NEW MEXICO SCHOOL OF MINES

THE WATER CONTENT OF MEDUSAE

DR. GORTNER'S faith[1] in a marine jelly-fish which is more than 99 per cent. water obviously can not be "flatly contradicted," but there are plenty of data which show his belief to be unfounded in the case of the commoner genera, and which justify skepticism.

In my paper I did not present new data because there was nothing to add to the old; but Dr. Gortner must have observed that the calculation of the "bound water" results in Table 3 necessitated routine determinations of total water. The total solid of *Cyanea* varied from 4.7 to 5.9 per cent., and that of *Aurelia* was always within the range given by Krukenberg. With Gortner's statement that the fraction of *organic* matter may be less than 1 per cent. I have no quarrel; indeed I once crudely estimated it by keeping a dead *Cyanea* in running tap water for 3 days and then drying it. The dry weight was 0.9 per cent. of the wet weight. The effect of the salts is clearly shown, also, by comparing the dry weight data of Krukenberg, whose jelly-fish came from the Gulf of Trieste, with those of Moebius, from the dilute sea water of Kiel Bay. The mean values for *Aurelia* were 4.88 and 2.08 per cent., respectively.

HEIDELBERG J. B. BATEMAN

QUOTATIONS

MEDICAL PATENTS

CEREMONIOUS opening of the new laboratories of an important drug manufacturing company is not an occasion on which we expect to hear plain speaking of the kind in which Sir Henry H. Dale indulged at Rahway, on the danger of being too practical in medical research, and of keeping a too eager eye on profits to be derived from the patenting of medical discoveries. The laboratories in question will undoubtedly develop many a useful remedy which will become the subject of a patent monopoly. Sir Henry spoke with authority. Once upon a time he was the director of just such a laboratory. Does not his own career argue against his contention that the pursuit of the practical is incompatible with the pursuit of pure science? He owes his present position of director of Great Britain's National Institute of Medical Research to the distinguished work that he managed to do as a chemist employed by a drug company whose patents are probably its most valuable assets.

There certainly has been no worshiping of false gods in the laboratories of the great German and American industrial organizations. Such Nobel Prize winners as Langmuir, Bosch and Bergius won their laurels as the employees of wealthy corporations. Indeed, certain kinds of research can apparently be conducted most effectively only with the financial aid and equipment of an industrial laboratory. If we want to learn anything about low-pressure chemistry, we must go to the General Electric Company; the best information on speech and hearing is likely to be obtained from the Bell Telephone Laboratories; the Eastman Kodak Laboratories are the recognized authorities on photochemistry. The larger and more liberal corporations have learned to leave their research staffs alone. Even pure science can not help making discoveries that yield a profit when exploited with the aid of patents.

Yet physicians as a class will endorse Sir Henry's warning. Deep down in all of us there is a repug-

[1] Karl A. von Zittel, "Text-Book of Paleontology," Eastman translation, p. 51, Macmillan Company, 1927.

[2] E. W. Berry, "Paleontology," p. 29, McGraw-Hill Company, 1929.

[1] SCIENCE, March 17, 1933.

nance to making money out of human suffering. Even the men in university laboratories who patent their medical discoveries share it. They apply at least part of their royalties to conducting fresh research. But it is a question whether royalties do not quench the disinterestedness that is the very essence of pure research. A patented drug becomes the object of jealous concern. Is it likely that the merits of a competitive product will be objectively appraised and conceded? Questions such as these were probably uppermost in Sir Henry's mind. No doubt the men who have given us patented insulin, patented liver extract and patented ergosterol can be trusted to observe the medical tradition. Yet there is a clear need for some method which will enable a researcher to obtain the money that he needs and yet pursue his studies with a serenity that knows nothing of profits. —*The New York Times.*

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SPRING MEETING OF THE EXECUTIVE COMMITTEE

THE spring meeting of the executive committee of the council of the American Association for the Advancement of Science was held at the Hotel Stevens in Chicago on March 24 and 25.

Dr. Fox, as executive secretary of the Committee on Foreign Guests for the Chicago meeting, reported regarding the acceptance of invitations issued jointly by the Century of Progress Exposition and the association, and also on the assignment of guests to sectional and society programs.

Dr. Fox stated that he had sent out communications from his office to colleges and universities in order to provide opportunities for such guests as desired invitations to lecture at various points. Different foundations in the United States have been cooperating with Dr. Fox in furnishing information concerning other foreign scientists whom they might have in this country about the time of the Chicago meeting. The executive committee voted that distinguished foreigners who expect to be in the country at the time of the meeting should be invited to participate as honorary foreign guests and members of the association for the Chicago meeting.

The permanent secretary laid before the executive committee the record of receipts and expenditures at the Atlantic City meeting and a summary of the condition of the various funds of the association up to February 28, 1933. From these data it appeared that the balances available were narrow and care must be exercised in making further appropriations. The paid-up membership had fallen off slightly but was still at an encouragingly high level. Some items regarding succeeding meetings were reported and especially the plans for the Boston meeting, which, due to a highly efficient local committee, had already reached a well-advanced stage.

The permanent secretary reported that since Dr. A. F. Woods had been elected a member of the executive committee at the Atlantic City meeting a vacancy in the council was created. Dr. W. W. Cort, of the School of Hygiene and Public Health of the Johns Hopkins University, was elected to fill the vacancy. Dr. Cort's term will expire at the close of the Pittsburgh meeting, in December, 1934.

Certain members, on the basis of credentials duly presented, were elected as fellows of the association.

The question of branch registration offices for the Chicago meeting was discussed. In view of the widely separated locations fixed upon by affiliated societies and sections and of the complexity of the program, the permanent secretary's office was instructed to arrange for branch registration at a limited series of places. This arrangement was approved for the Chicago meeting only.

The presentation of the financial report led to a discussion regarding miscellaneous expenses. The permanent secretary was requested to prepare a communication to section secretaries, urging the need of economy and pointing out the necessary limitations in incurring expenses in connection with the work of the section. It was voted that other items of expense than those regularly included under the regulations of the association be paid only provided that approval was secured from the office of the permanent secretary before the expense had been incurred.

The permanent secretary was asked to revise the general statement for travel and per diem allowances of executive committee members and section secretaries so as to provide for pro-rated distribution of expense whenever travel is undertaken for purposes other than those of the meeting.

In view of general economic conditions and of the two meetings held this year it was voted that section secretaries in attendance at the Chicago meeting be allowed actual minimum railroad fare plus pullman charges and a room at the headquarters hotel as regularly arranged for by the permanent secretary's office for a period not to exceed one week. The per diem allowance was discontinued for the Chicago meeting.

In view of the special circumstances surrounding the summer meeting, the permanent secretary's office was authorized to extend invitations to persons living within a radius of three hundred miles from Chicago to join the association until July 15, 1933, without making payment of the usual entrance fee.

Information was presented to the executive committee that a volume containing papers delivered at the symposium on "The Stabilization of Employment," held in connection with the Atlantic City meeting, had been printed by the Principia Press. The volume was edited by Dr. Charles F. Roos, former permanent secretary. The Principia Press and the Far-Reaching Foundation of Denver proposed to distribute a special edition of the volume to the president, members of Congress and other national officers. The permanent secretary was authorized to prepare and approve the use of a statement to accompany each volume to indicate the part of the association in the undertaking.

The payment of life membership fees in instalments as approved by the council in the Atlantic City meeting was further considered by the executive committee and it was voted that such payment be approved in instalments of not less than $20 in each of five successive years. Such periodic payments would include the annual dues for each year during this period. The permanent secretary was requested to formulate the exact conditions of the plan and present the same for record and approval at the next meeting of the executive committee.

Dr. Henry Norris Russell, president of the association, was delegated as its representative for the meeting of the British Association for the Advancement of Science to be held in Leicester, from September 6 to 13, 1933.

Correspondence from the general secretary of Phi Beta Kappa was presented to the committee, and the permanent secretary was asked to invite that organization to arrange for an address at the Boston meeting, the address to be given by a leading scholar.

Various communications concerning the great increase in the cost of German scientific publications were read to the committee and discussed at considerable length. The possible complications as affecting intimate contacts and proper exchange of information between scientific men were pointed out. In view of the opportunity for misinterpreting definite action, the matter was laid aside for the present.

The proposal to select from the fellows in membership in the association a certain number to be designated as research fellows was presented and after much consideration was on recommendation of the chairman made a special order of business for the June meeting.

The finance committee presented a report regarding defaulted interest payments on mortgages held in the endowment funds, and it was voted that collection of interest should not be pressed during present conditions.

The committee was entertained at luncheon Saturday noon at the Administration Building of the Century of Progress Exposition. Following the luncheon there was a joint meeting with some of the officers of the Century of Progress and with the local committee for the Chicago meeting. Opportunity was afforded for seeing plans of the exposition, learning of the progress made on the installation of scientific features of the same and the general outlook for the exposition. Reports were made by members of the local committee representing individual sections and affiliated societies. They showed that the plans had been adequately worked out, that the work was well advanced towards completion, and that the exhibits, facilities and programs assured not only satisfactory conditions for the summer meeting but a scientific gathering of unusual extent and significance.

HENRY B. WARD,
Permanent Secretary

HOTEL HEADQUARTERS FOR THE CHICAGO MEETING

THE local committee has arranged for the Chicago meeting, the hotel headquarters of the association and its sections as follows:

General Headquarters: Stevens Hotel, Michigan Avenue at 7th Street.
Section A (Mathematics): Judson Court, University of Chicago.
" B (Physics): Windermere Hotel, 1642 E. 56th Street.
" C (Chemistry): Hotel Sherman, 106 W. Randolph Street.
" D (Astronomy): Hotel Stevens, Michigan Avenue at 7th Street.
" E (Geology): Southmoor Hotel, 67th at Stony Island Avenue.
" F (Zoology): Hotel Stevens, Michigan Avenue at 7th Street.
" G (Botany): Hotel Stevens, Michigan Avenue at 7th Street.
" H (Anthropology): Bismarck Hotel, 175 W. Randolph Street.
" I (Psychology): Great Northern Hotel, 237 S. Dearborn Street.
" K (Social and Economic Sciences): Hotel Stevens, Michigan Avenue at 7th Street.
" L (Historical and Philological Sciences): Drake Hotel, Lake Shore Drive and Michigan Avenue.
" M (Engineering): Palmer House, 15 East Monroe Street.

Section N (Medical Sciences): Knickerbocker Hotel, 163 E. Walton Place.
" O (Agriculture): Morrison Hotel, Madison and Clark Streets.
" Q (Education): Drake Hotel, Lake Shore Drive and Michigan Avenue.

The affiliated societies are in general housed in hotels of the section to which they are related. The engineering societies, however, are distributed as follows:

Palmer House: American Society of Civil Engineers; American Society of Mechanical Engineers.
Edgewater Beach: American Institute of Electrical Engineers.
Stevens Hotel: American Institute of Mining and Metallurgical Engineers; American Society for Testing Materials; Society of Industrial Engineers; American Ceramic Society; Society for the Promotion of Engineering Education; National Council of State Boards of Engineering Examiners; American Foundrymen's Association.
Hotel Sherman: Institute of Radio Engineers.

For those who may be coming to Chicago by car and may be interested in automobile camps, the following operated by the Century Cabins, Inc., 7 South Dearborn Street, have been approved by the Century of Progress:

Desplaines Avenue where crossed by Chicago Rapid Transit Line, Forest Park, Illinois. On World's Fair marking—Illumination Route—U. S. 330—Lincoln Highway.

Milwaukee Avenue and Oakton Street, Park Ridge, Illinois. On World's Fair marking—Radio Route—Illinois Route No. 21—Milwaukee Avenue.

22nd and Manheim Road, Westchester, Illinois. On World's Fair marking—Illumination Route—U. S. 330—Lincoln Highway.

Other camps are no doubt available, information concerning which can be obtained from automobile associations and clubs.

Correspondence regarding reservations should be sent directly to the appropriate hotel. Members are advised to make early application for rooms and to specify their connection with the association. It is important to have a definite understanding regarding space and rates.

THE NATIONAL ACADEMY OF SCIENCES

ABSTRACTS OF PAPERS PRESENTED AT THE WASHINGTON MEETING

AT the annual meeting of the National Academy of Sciences, held in Washington, D. C., on April 24 and 25, the following papers were presented:

Geometry of the Laplace equation: EDWARD KASNER. The Laplace differential equation, $\frac{\partial^2\varphi}{\partial x^2}+\frac{\partial^2\varphi}{\partial y^2}=0$, has its origin in the theory of gravitation, φ being the potential; but of course it is of importance in many other branches of physics and in the theory of functions of a complex variable. The curves $\varphi(x, y)$ = constant constitute an isothermal family, so called because they are the curves of equal temperature in a steady flow of heat. The author finds purely geometric properties of such families. We state seven of these properties as follows, each one being completely characteristic: (1) If we construct the osculating circles at any point P of the curve of the given isothermal family and the orthogonal trajectory, these circles meet at another point P_1, and the transformation T from P to P_1 is conformal. (2) A related transformation is of the Darboux type. (3) If we construct all the ∞^2 isogonal trajectories these form a natural family of the kind arising in optics and in the dynamics of conservative forces. (See Kasner's Princeton Colloquium Lectures.) (4) Of all the isogonal trajectories at any point P, two will admit circles of curvature of higher than second order contact, and these two will be orthogonal. (5) The isogonal trajectories form a linear family (as proved by the writer in *Math. Annalen*, 1904), and therefore we can form a Desargues configuration. This gives a characteristic construction in finite form. (6) Any isothermal family and the two families of minimal straight lines form a Blaschke hexagonal web. (7) Any isothermal net may be regarded as the orthogonal projection of the asymptotic lines of some surface. In conclusion, various geometric operations are described by means of which given isothermal families yield new isothermal families. The generalization to the Laplace equation in three dimensions is not direct and will be studied in another paper.

The geometry of spinors: OSWALD VEBLEN.

Finding the velocities of the spiral nebulae: V. M. SLIPHER. This paper gives a brief account of the velocity studies of the spiral nebulae made at the Lowell Observatory, where work in this field was begun. It touches on the development of the efficiency of the instruments for the work and gives results. There are mentioned the early tests and the reasons stated in support of the velocities being real in spite of their most extraordinary magnitudes. Examples of nebulae in rapid rotation are cited, and objects are referred to which are of exceptional interest because of their speeds of translation or rotation or because of their exceptional spectra.

Absorption and space reddening in the galaxy from the colors of B-stars: JOEL STEBBINS and C. M. HUFFER. The stars of spectrum class B, with intrinsic luminosities ranging from a hundred to several thousand times that of the sun, furnish an excellent means for testing the presence of dark matter in space. With a photo-electric cell attached to a 15-inch telescope, the brightness and colors of some seven hundred B-stars have been determined at the Washburn Observatory of the University of Wisconsin. This survey of such objects in the northern sky, complete down to visual magnitude 7.5, has been supplemented by measures of fainter stars and clusters with the large reflectors at Mount Wilson. The observations confirm the existence of a layer of absorbing material in our stellar system, extending along the central plane of the Milky Way. For distances of the first few hundred light-years the effect of this dark gas or dust is inappreciable, but from five hundred to five thousand light-years from the sun the absorption and space reddening become increasingly evident. The present results are in striking agreement with distribution of extra-galactic nebulae determined by Hubble at Mount Wilson. Where the nebulae appear in great numbers the stars are normal in color, but in obscured regions, where the nebulae can not be photographed through the veil in the foreground, the stars show a pronounced effect of coloration. Due to the eccentric position of the sun in the galaxy, stars in the outer regions, like those of the constellation of Orion, are less affected than objects in the opposite direction toward the center of the galaxy, where the loss from absorption amounts to at least three fifths of the visual or five sixths of the photographic light. The growing evidence from B-stars, globular clusters and nebulae supports the conclusion that we do not see out as far as the galactic center, and that objects hitherto supposed to be beyond the nucleus are really on this side of the center of the system. The scale of stellar distances must be revised with allowance for the effect of absorption. Finally, because of the general amount and extent of the obscuration, it is shown that the dark matter in space, counting only that which has so far been detected, may well be greater in total mass than the luminous material which we see in the form of shining stars.

Luminosity curves and average density of matter in twenty-five groups of galaxies: HARLOW SHAPLEY. Preliminary calculations at Mount Wilson and at Harvard have indicated that the average density of matter in intergalactic space is of the order of 10^{-30} grams per cubic centimeter. Throughout large volumes of space, however, the density is much higher and its evaluation is of significance in consideration of the evolution of the Metagalactic System. The luminosity curves of the galaxies in twenty-five groups, differing in richness, angular extent and volume, have been found from Harvard observations, with appropriate corrections for the random galaxies of the general metagalactic field. The luminosity data permit estimates of distance and mean density. The number of galaxies per cubic megaparsec in the groups varies from ten times to more than a thousand times the average number for metagalactic space. These groups of galaxies (super-galaxies) occur occasionally in pairs, the boundaries of the component groups separated apparently by less than the diameter of either.

On the masses of binary stars: HENRY NORRIS RUSSELL and CHARLOTTE E. MOORE. The dynamical parallaxes computed by the writers have been revised by the inclusion of new material for many stars, and compared with determinations from other sources. We are indebted to Dr. Schlesinger for access to the Yale card catalogue of trigonometric parallaxes, to Dr. Adams for unpublished spectroscopic parallaxes from Mt. Wilson, and to Dr. Aitken for valuable double star measures. These comparisons indicate a close agreement with Eddington's mass-luminosity relation, for giants and dwarfs alike, with the well-known exception of the white dwarfs. The total number of stars available for investigation of mass is approximately five hundred and sixty.

The absolute motion of the solar system and the orbital motion of the earth, determined by the ether-drift experiment: DAYTON C. MILLER.

Solar variations and atmospheric pressure: H. H. CLAYTON (introduced by C. G. Abbot).

Long-range forecasting: C. G. ABBOT. There is presented with verification a two-year forecast of the variation of the sun made in November, 1930, and published in February, 1931. The average deviation of observed from predicted monthly mean values is 0.3 per cent. The analysis of solar variation from January, 1924, to September, 1932, and its exhibition as the summation of seven regular periodicities of 6–2/3, 8, 11, 21, 25, 45, and 68 months, respectively is presented. The average deviation of this summation from observed monthly mean values, is 0.15 per cent. The author ventures a detailed forecast of solar variation to December, 1934. Expected values generally below normal, with strong minima June, 1933, and July, 1934. The author presents the analysis of the departures from normal temperature of Bismarck, North Dakota, from 1875 to 1925. In addition to the seven periodicities found in solar variation, he finds others of 9–1/2, 12–3/4, 18 and 135 months, respectively. All these periodicities continue over the 50-year period from 1875 to 1925, but with fluctuations of amplitude, phase and form. He attempts to determine empirical relations governing these fluctuations. Employing the preferred adjustments of this kind, he compares the summation of adjusted periodicities with the actual departures from normal temperature, 1875 to 1925. Finally, he compares his forecast for 1925 to 1932 with observed departures of that interval.

The phosphorescence of solid nitrogen and its relation to crystal structure: L. VEGARD.

Forbidden lines in astrophysical forces: JOSEPH C. BOYCE, DONALD H. MENZEL and CECILIA H. PAYNE (introduced by Harlow Shapley).

The physical state of Novae: DONALD H. MENZEL and CECILIA H. PAYNE (introduced by Harlow Shapley).

The action of the parenteral administration of sugars in the hydrogen-ion concentration of normal and malignant tissues in living animals: CARL VOEGTLIN, H. KAHLER and R. H. FITCH (introduced by C. S. Hudson). [To be printed in SCIENCE.]

Crystalline pepsin and trypsin: JOHN H. NORTHROP (introduced by Simon Flexner). A crystalline protein (pepsin) which digested other proteins in acid solution with great rapidity was isolated three years ago from commercial pepsin preparations. More recently another crystalline protein (trypsin) which digests other proteins in slightly alkaline solution has been isolated from pancreas. These proteins behave like pure substances in that the chemical and physical properties, including enzymatic activity, are the same in a number of different preparations and are not changed by repeated fractional crystallization. Partial destruction of the protein by heat, acid, gamma rays or ultra-violet light, results in a corresponding loss in activity. The inactivation by heat is partly reversible. These results confirm the conclusion that the enzymatic activity is a property of the protein molecule. A number of physical and chemical properties of the proteins have been determined.

Gluconeogenesis from Fat: JOHN R. MURLIN (introduced by Lafayette B. Mendel). There has been much theorizing but little convincing evidence in favor of the conversion of fatty acids to glucose in the animal body. It is certain that the reaction at best is difficult and probably takes place very little at a time, if at all. Studied by the method of respiratory metabolism the conversion should give a low R.Q., but if it were followed immediately by combustion of the sugar the low R.Q. would blend with a high R.Q. and the evidence consequently would be obscured. With the castor bean it has been possible to separate the two reactions clearly. Conversion of fatty acids to cane sugar takes place in the endosperm and its oxidation in the young plant. With the help of Drs. R. G. Daggs and H. B. Pierce we now have the evidence complete, (1) by the R.Q., (2) by combustion in a modified oxycalorimeter, and (3) by chemical analysis. With the assistance of Drs. Estelle E. Hawley and Carroll W. Johnston, an attempt has been made to devise conditions for the human subject, which would possibly separate conversion from combustion. Deprived of glycogen the tissues, offered sugar, prefer to restore the glycogen rather than burn the sugar. If under these conditions easily assimilable fat were offered and if any glucose were formed, it would be converted to glycogen and retained, thereby disclosing low R.Q.s. Later it would be oxidized, giving a special sequence of quotients following a high-fat meal, namely, first low, then medium, then high. Seven subjects have been used, and rich cream (approximately 40 per cent. fat) furnished the sole diet for several days. Thereby glycogen was reduced and a flood of fatty acids became available suddenly to supply materials for replacement. The special sequence of quotients predicted was obtained several times especially at an early test for each subject. Later the phenomenon of adaptation or increased tolerance for fat supervened to obliterate this sequence. Many very low R.Q.'s were obtained, however, outside the predicted sequence. There are three other known ways of explaining low R.Q.s, aside from the conversion of fatty acids to glucose: (1) Formation of sugar from protein; (2) formation of sugar from glycerol; (3) production of the acetone bodies. Consideration of these several reactions under the conditions of the experiments described proves that none or all of them combined can explain the lowest R.Q.s obtained. The latter undoubtedly are correct, for they have been duplicated many times by both the Benedict and the Tissot-Haldane techniques. It seems clearly possible, therefore, that we have here a method of demonstrating gluconeogenesis from fat. To make it perfectly convincing we should be able, as in the castor bean, to find the sugar. That has not yet been accomplished.

Origin of bioelectric potentials: W. J. V. OSTERHOUT. In *Nitella* (as in muscle and in nerve) we find an outwardly directed potential on which the current of action and the current of injury depend. Our experiments on *Nitella* indicate that this may be largely due to the diffusion potential of potassium salts which exist inside at a higher concentration than outside (the mobility of the potassium ion in the protoplasmic surface is apparently very high). This has a paradoxical look because the potassium must penetrate from the outside and thus diffuse inward against an electrical gradient created by itself. It is therefore of considerable interest to find that suitable models can do this very thing and can imitate in many other ways the behavior of the living cell. The apparent paradox is explained by the fact that potassium penetrates in one form and goes out in another and that it sets up less diffusion potential in entering than in leaving the cell. In the model, as in the living cell, a non-aqueous layer lies between two aqueous phases and more potential is produced in this layer by potassium than by sodium. But if certain substances be removed from the non-aqueous layer potassium produces no more effect than sodium. Experiments in collaboration with S. E. Hill show that a similar change is brought about by treating the living cell with suitable solutions. The cell is then in a state of anesthesia: it is no longer excitable by ordinary electrical stimuli. The process is perfectly reversible. This suggests that anesthesia is due to the removal of certain substances from the cell.

The precocious development of sexual characters in the fowl by daily injections of hebin: L. V. DOMM and H. B. VAN DYKE (introduced by F. R. Lillie). Brown Leghorn cockerels ranging from 1 to 47 days in age received daily subcutaneous injections of hebin. The quantities administered ranged from 4 to 32 rat units in single daily injections. The duration of the experiments varied from 14 to 36 days. The first effect noticed was a pronounced stimulation of head furnishings. This could be definitely noted, in some instances, as early as 48 hours after injections began. The comb revealed steady growth throughout and at the conclusion of experiments was usually considerably larger than controls. Precocious sexual behavior was noted. Young males were found crowing when 9 days old and to reveal

the initial treading reactions at 13 days. Post-mortem revealed hypertrophy of testes. These were usually larger and heavier than controls. Thyroids were likewise larger and heavier in treated birds. The spleen, liver and heart did not seem to show significant changes in weight though experimental spleens were fairly consistently somewhat lighter than controls. The ductus deferens revealed hypertrophy. In the cases studied histologically tubules of control testes were distinctly juvenile showing primordial germ cells, whereas those in treated testes revealed spermatogenesis. Thyroids from treated individuals revealed larger vesicles. In a second series of experiments brown Leghorn females received daily subcutaneous injections of hebin. Concentrations injected, age range, and duration of experiments were identical with the experiments on cockerels. Here also the first effect noticed was a striking growth of head furnishings. This was definitely noticeable within 48 hours in individuals receiving higher concentrations. In such experiments head furnishings revealed a continuous high growth rate throughout becoming masculine in character. The comb became stout of blade and erect whereas that of similar size in normals, only found in much older females, shows a thin loppy blade. Plumage and behavior were apparently unaffected. Post-mortem revealed considerable hypertrophy of ovaries. These were larger and heavier than controls but showed no indications of ovulation. The surface of more advanced ovaries had a mulberry appearance indicating follicular development. The more advanced oviducts showed astonishing hypertrophy comparable to that normally preceding ovulation. The weight of these frequently exceeded 15 times that of controls. Thyroids were larger and heavier than controls. Differences in weights of liver, spleen and heart were probably not significant though experimental spleens were usually heavier. Histologically experimental ovaries showed larger follicles. Sections of normal oviducts showed low mucous folds devoid of tubular glands and conspicuous muscle layer, whereas experimentals showed high mucous folds, well-developed tubular glands and conspicuous peripheral muscle layer. Experimental thyroids showed larger vesicles. Effects were in general proportional to concentrations injected. The results generally confirm the earlier experiments of Domm ('31) following daily hypophyseal implants on juvenile males and females.

The anterior hypophyseal substance which synergizes with prolan: HERBERT M. EVANS, MIRIAM E. SIMPSON and PAUL R. AUSTIN. In 1931 Evans, Meyer and Simpson[1] discovered that the gonadotropic effect of the substance found in the urine of pregnant women (prolan) is greatly increased if certain extracts of the anterior hypophysis, themselves of low gonadotropic potency, are added to prolan. The phenomenon has been recently confirmed by Leonard,[2] similar synergistic effects with prolan having been secured by him through the employment of extracts high in gonadotropic potency. Our earlier experiments led to the suggestion of the growth hormone as the synergistic substance, while the Leonard series provoked his hypothesis that the gonadotropic hormone itself was involved. Continued study of the phenomenon has shown that the anterior hypophyseal substance which increases the gonadotropic effects of prolan (when mixed *in vitro* with prolan) is neither the gonadotropic nor growth hormone. The new substance does not possess either growth- or gonad-stimulating properties, and is characterized by physical and chemical traits which clearly distinguish it from the hormones in question.

The effects of deprivation of magnesium in the animal body: E. V. MCCOLLUM, H. D. KRUSE and ELSA R. ORENT. When young rats are deprived of magnesium but are given adequate amounts of other dietary essentials, they show a spectacular series of symptoms denoting a condition that is short and abruptly fatal in its course. Successively they pass through stages of vasodilatation and hyperirritability of the nervous system before succumbing in tonic-clonic convulsions. This syndrome fits into the category of tetany, when the term is used in its broadest sense. It has, however, characteristic features that differentiate it from all other forms of tetany. The chemical changes in the blood serve as further evidence to the distinctiveness of magnesium tetany, since magnesium is the only inorganic ion undergoing alteration. Adult males, restricted to the magnesium-deficient ration, suffer damage of the reproductive system, resulting in sterility. A study of females as yet is incomplete. In addition to these effects on the nervous and reproductive systems which may be designated as local effects, adult animals show constitutional changes in the form of nutritive failure, which is reflected in loss of body weight. Again, chemical examination of the blood offers an explanation of the nutritive failure, since it reveals an unusual disturbance in lipid metabolism unlike that seen hitherto in any other disease. It has been asserted that the mechanism of failure in fasting and deficiency diseases is identical; the blood picture in magnesium deficiency indicates that the mode of failure is entirely different in the two conditions. Studies of inorganic metabolism in animals deprived of magnesium reveal that while the animal runs a negative magnesium balance it retains calcium in the earlier stages to an extent far in excess of control animals. If the animal has a long survival, period, however, this retention of calcium is broken. The retention of calcium is reflected in the calcification of the long bones, analyses of which show a higher content of calcium.

Rate of development of primate embryos: G. L. STREETER. Being able to study macaque embryos of known age throws light on the rate of development during the first few embryonic weeks concerning which in human specimens only inadequate clinical data have thus far been available. The two genera differ in minor details of form and in rate of differentiation but these differences become progressively less in the early stages. The close morphological parallelism between embryos of monkey and man will be shown and a comparison will be made be-

[1] H. M. Evans, K. Meyer and M. E. Simpson, "The Relation of Prolan to the Anterior Hypophyseal Hormones," *Proc. Soc. Exp. Biol. and Med.*, 28: 845, 1931.

[2] S. L. Leonard, "Increased Stimulation of Immature Rat Ovaries by Combined Injections of Prolan and Hypophyseal Sex Hormone, *Proc. Soc. Exp. Biol. and Med.*, 30: 665, 1933.

tween some of the well-known human specimens and similar monkey specimens of known ages.

Morphine and the cat: WILDER D. BANCROFT, ROBERT S. GUTSELL and JOHN E. RUTZLER, JR. It is usually stated that the action of morphine on the cat is fundamentally different from its action on man or on the dog, the cat becoming violently excited. We have tested six cats with varying amounts of morphine—five to twenty milligrams per kilogram—injected subcutaneously and intramuscularly. While the cats showed a slight excitement, there was nothing approaching mania, and it is not certain that the effect is anything more than the irritability corresponding to sub-anaesthetic doses. Oral administration of sodium rhodanate decreases the excitement produced in cats by morphine. Toxic, but not lethal, doses destroy the excitement almost completely. In the presence of histamine, an agglomerating agent, the effect of morphine lasts almost twice as long. Morphine caused dilatation of the pupils and a doubling under of the hind quarters in all six cats. Sodium rhodanate eliminated the doubling under but had no appreciable effect on the dilatation. A few men and more women are said to become violently excited under morphine and this is said to be true of all human beings in the manic state. There is therefore no fundamental difference in the action of morphine on men and on cats though the relative incidence of the drug is undoubtedly different. It is possible that a greater percentage of cats than of men become violently excited by morphine; but there is no real evidence either way.

The isotopic fractionation of water: EDWARD W. WASHBURN, EDGAR R. SMITH and MIKKEL FRANDSEN. When water is subjected to electrolysis an isotopic fractionation occurs.[1] It has been found that the heavier isotope of hydrogen and the heavier isotopes of oxygen are concentrated in the residual water. The specific gravity of the residual water rises continuously as the electrolysis proceeds. The rise in specific gravity is accompanied by a rise in the freezing point and in the boiling point and by a decrease in the refractive index. No indication of approach to an electrolysis equilibrium has been found, and there is every reason to hope that it will be possible to obtain the various isotopes of hydrogen and oxygen in a pure state, certainly in highly concentrated form. If the oxygen from the electrolysis of normal water is combined with normal hydrogen, the water produced has a lower specific gravity than normal water. If this water be again partially electrolyzed and the oxygen combined again with normal hydrogen, a further drop in the specific gravity of the water occurs. It will consequently be possible to prepare isotopically pure water of the composition $H^1O^{16}H^1$ and hence to determine very accurately the atomic weight of normal oxygen on the $O^{16} = 16$ scale. With the different isotopes of hydrogen and oxygen available in pure form, a new field of chemistry and possibly also of biology will be opened up, since the different isotopes of hydrogen, at least, may be expected to exhibit pronounced differences in chemical behavior. A survey is being made of water from different natural sources to find out whether differences in isotopic composition occur in nature.

[1] Washburn and Urey, *Proc. Nat. Acad. Sci.*, 18: 496, 1932.

Neutrons and atomic nuclei: WILLIAM D. HARKINS. The neutron is an electrically neutral nuclear particle of about 10^{-13} cm diameter and of about the mass of a hydrogen atom. The existence of neutrons in the radiations from beryllium, when a piece of this material is bombarded by fast α-particles, was recognized by Chadwick in 1932. That the nucleus of the beryllium atom contains a neutron was assumed in 1915 by Harkins and Wilson, and the characteristics of free neutrons were given in 1920 by the writer and by Rutherford. Photographs of the disintegration of nitrogen nuclei by fast neutrons from beryllium have been obtained by Gans, Newson and the writer. One of these photographs shows the effect of a neutron of extremely high energy, which amounts to 15 million electron volts or a velocity of about 33 thousand miles per second. This is by far the fastest neutron thus far detected. The work of Feather in Cambridge, together with that of this laboratory, indicates that in disintegrations of nuclei by neutrons kinetic energy is either conserved or disappears and is converted into gamma-rays. The energy found to disappear in the reaction—Nitrogen 14 + Neutron 1 = Boron 11 + Helium 4—is represented by only a few definite energy values, so it seems probable that definite energy levels exist in some of the nuclei involved, in that of boron of mass 11. A neutron plus a proton may be assumed to form a hemi-alpha particle or nucleus of a hydrogen atom of mass 2. Certain interesting relations are found if it is assumed that atomic nuclei consist of alpha particles, neutrons and hemi-alpha particles. These will be discussed in connection with the Harkins-Masson nuclear formula $(np)_Z{}^n{}_p$, or $\left(\frac{\alpha}{2}\right)_Z{}^n{}_I$, in which Z is the atomic and I the isotopic number; n, a neutron; p, a proton; and α represents an α-particle of group. The completion of an α-particle in a nucleus by the addition of a hemi-α-particle gives an extremely large amount of energy: 20 million electron volts or more. It is found that neon gives the smallest and nitrogen the largest number of nuclear disintegrations from bombardment by neutrons of the three gases thus far tested—nitrogen, oxygen and neon. Experiments with other gases, such as ethylene, are in progress.

A possible alternative formula for sucrose: C. S. HUDSON and C. B. PURVES. In an attempt to prepare a methyl fructoside possessing the same ringed structure as that depicted for the fructose residue in the generally accepted formula for sucrose, cane sugar was dissolved at room temperature in methyl alcohol containing hydrogen chloride. The reaction was found to proceed with remarkable rapidity and to give rise initially to glucose in a reducing condition and to a mixture of methyl fructosides of a gamma type. On the basis of the usual structure for sucrose, stable alpha methyl glucoside and an individual beta methyl gamma fructoside had been expected as the sole initial products of the reaction. This unforeseen result induced the authors to review the experimental evidence upon which the chemical constitution of sucrose is at present based and they point out that the

whole of these experimental data can be equally well satisfied by an alternative structure for the disaccharide. In the possible alternative structure sucrose is regarded not as a glucosido gamma fructoside but as a dicyclic acetal condensation product of open chain glucose and open chain fructose.

The widths of the K absorption limits in x-ray spectra: F. K. RICHTMYER and S. W. BARNES. By means of a two-crystal spectrometer the widths of the following elements have been studied: Mo(42), Ag(47), In(49), Sn(50) and W(74). Except in the case of Sn(50) none of the limits showed any trace of fine structure. After making an approximate correction for the width of the rocking curves of the pair of crystals used, the widths of the several limits in volts are as follows: Mo(42), 18 volts; Ag(47), 28 volts; In(49), 31 volts; W(74), 133 volts; Au(79), 160 volts. Within experimental error there seems to be no difference between the limit of Ag(50) in the metal and in the oxide. The absorption limit of Sn(50) seems to show a structure which perhaps may be associated with the fact that Sn has a large number of isotopes, in contrast with Ag, which has two, and In, which has only one constituent.

New optical properties of the alkali metals: R. W. WOOD. Continuing an investigation made over fifteen years ago, on the remarkable transparency of films of sodium and potassium to ultra-violet light, and their opacity and high reflecting power in the visible region, it has now been found that there is a fairly sharp transition point in the spectrum at which an alkali metal ceases to exhibit the properties of a metal and assumes those of a dielectric. A potassium film, through which the sun's disc is invisible, transmits 25 per cent. of the energy in the region between 3,000 and 1,860. For this spectral range it gives plane polarization by reflection of unpolarized light, having a Brewsterian angle of about 37°. The spectrum of a light source giving a continuous spectrum, reflected from a film of the metal several wavelengths in thickness, shows interference maxima and minima the fifth order or higher being recorded. The transition point, at which the properties change, descends in the spectrum, with decreasing atomic number being at about 4,000 for caesium and 2,000 for lithium. The use of the films as ray filters for spectroscopic work will be discussed.

Application of the three-color principle to oil painting: HERBERT E. IVES. The experimentally well-established fact that all colors may be matched by the mixture of three properly selected primaries has been extensively used in color photography and typographic printing. It has not, however, been heretofore successfully used in painting. The usual artist's palette consists of a dozen or more pigments, with the result that the number of ways of making desired colors by mixture is very large and quite unamenable to systematization. Learning how to use these numerous pigments is a matter of long experience. The simplification indicated by the three-color principle has been retarded in realization largely owing to the mistaken but widely held belief, that the primary pigment colors are red, yellow and blue. Actually the pigment primaries, which act by subtraction or absorption of light from white, should be complementary in hue to the red, green and blue, which are the primaries for mixing light by addition. Those colors are a minus red (spectrum minus red) or turquoise, a minus green, or crimson, a minus blue, or yellow, each having wide overlapping spectral reflection bands. Pigments of these colors, of proper spectral characteristics, are capable of mixing in pairs to make red, green and blue, and all three together to make black. When mixed with white all variations of saturation and hue are obtained. The practical problem consists in procuring pigments possessing the indicated spectral reflectivities and having satisfactory chemical properties, such as freedom from reaction with the oil or other medium, and satisfactory permanence. Due to the very great advances which have been made in the dye industry to meet recent demands for permanent colors for automobiles and outdoor signs, it is now possible to select pigments nearly enough meeting the scientific requirements to test the practicability of the principle. This has been done with success, and pictures so painted are exhibited in connection with the presentation of this paper.

On supraconductivity and the Hall effect: EDWIN H. HALL. The experiments of Onnes from which he concluded that the Hall effect does not exist in the supraconductive state of metals are inconclusive. These experiments were of two kinds. In one the metal under examination was tested in the usual direct method which reveals the effect in the ordinary conductive state. In the other a metal spherical shell, in which persistent (self-sustaining) currents had been set up, was subjected to a magnetic field which, in the opinion of the experimenter, tended to swing the currents into new orbits within the metal. Failure to discover such a deflection led Onnes to infer the non-existence of a Hall effect. There is reason to doubt whether in either of these methods of experimentation the magnetic lines of force penetrated the metal to any appreciable degree. A different procedure for testing the question at issue is proposed.

The Pleistocene diversion of the Mississippi River across Crowley's Ridge, southeastern Missouri: F. E. MATTHES. The lower Mississippi Valley throughout its upper half is divided longitudinally into two parallel lowlands by a narrow strip of hilly upland, 100 to 250 feet high, known as Crowley's Ridge. Originally the Mississippi followed the lowland on the west side of this ridge, but now the river cuts across it at Thebes, Illinois, in spite of the fact that the ridge there is seven miles broad and composed in part of hard limestone. In consequence of this remarkable change in course the Mississippi now joins the Ohio 200 miles north of its original point of confluence with that river, and the entire drainage net in a valley area aggregating 17,000 square miles has been rearranged. Recent investigations have shown that the diversion of the Mississippi at Thebes and other

diversions of its waters at points now indicated by abandoned gaps in Crowley's Ridge were brought about, not by capture of the river by southward flowing streams, as has been supposed, but by overflow at a time, late in the Pleistocene epoch, when the Mississippi had aggraded its valley with silt derived from the continental ice sheet to a level about 50 feet above the present flood plain. Numerous terraces composed of glacial outwash material afford the principal evidence. The Ohio River also played a part in connection with the diversion of the Mississippi River. It flowed at that time across southern Illinois, through the valley now occupied by Cache River. By paring away the southeastern edge of Crowley's Ridge it beheaded several northwestward draining valleys and thereby created spillways at fairly low levels.

Archean formations of the Grand Canyon: IAN CAMPBELL and JOHN H. MAXSON (introduced by John C. Merriam). The oldest rocks exposed in the Inner Gorge of the Grand Canyon comprise a thick and varied metamorphic series (Vishnu schist). These rocks are invaded by granitic intrusives (phantom granite). So complex and so intimate are the relations between the metamorphic series and the igneous rocks that in many instances the resulting formation can only be described as a migmatite. The original sedimentary nature of the schists is shown by the occurrence of quartzite, calcareous members, iron formations and sandstone lentile in slightly altered schists. It is also indicated by retention of such characteristic sedimentary structure, as stratification and cross-bedding. Following the regional metamorphism of the sediments, the phantom granite was emplaced by processes of assimilation and granitization. Different facies of the granite and its associated pegmatites resulted from differing character and intensity of deuteric alteration.

Some features of flowers and fruit of a new Cordaites: DAVID WHITE. Fossil plant fragments of Pottsville age discovered in southeastern Illinois by the State Geological Survey disclose leaves, flowers and seeds of a single species of *Cordaites*. Male and female flowers, *Cordaianthus*, are small, bud-shaped and nearly alike. The young seed in the midst of the flower is narrow, soft and is deficient in wing. Stamens, protected like the ovules, by bracts when young, are numerous in the upper part of male flowers, protruding beyond the bracts and arching bouquet-like when mature, with oblong pollen sacs strewn along the upper ends. The base of the stamen seems exactly axillary. The small seeds (*Cardiocarpon*) are longitudinally oval-rhomboidal, with spinose glandular sarcotest, widely dilated as wing and narrow cordate-oval acute "hard" coat. No clearly defined pollen character is noted in the material, consisting of impressions and carbonized residues only. The micropylar canal is distinct, even in immature seeds. In some large seeds, structures, apparently tubular and seemingly continuous with the micropyle, extend, while dilating somewhat, far down into the interior of the endosperm. These structures, which the author is unable to regard as fungal, are interpreted as indicating a stage of development at which the archegonial wall and part of the endospermic center had broken down. No embryo has definitely been recognized in any Paleozoic seed.

Primitive cephalopods: AUG. F. FOERSTE (introduced by David White).

Metaxenia and neophosis, two forms of morphogenetic influence exerted by the generation-complex of the embryo sac apparatus in higher plants: WALTER T. SWINGLE (introduced by R. A. Harper). [To be printed in SCIENCE.]

The effect of alternation from spores to vegetative cells on the growth and activity of certain anaerobic bacteria: E. B. FRED and E. MCCOY. In a study of the factors that govern the growth and activity of bacteria, little consideration has been given to the effect of periodic changes from the spore to vegetative stage. Occasional statements have been made that the spore stage represents a regenerative phase of the cycle and that vegetative cells immediately following germination are of greater vigor and activity. The anaerobic bacteria represented by *Cl. acetobutylicum* and *B. amylobacter* (Bredemann) were chosen for the study of the effect of serial transfer involving periodic change from spores to vegetative cells. At regular intervals of four to five days the cultures were subjected to heat treatment of 1.5 minutes at 90° C. and were then used for subcultures in the usual way. All tests were made in 2 per cent. corn mash, a medium known to be suitable for the growth and sporulation of these organisms. At the present time the experiment has been carried to the one hundred and tenth transfer. Results of the comparison of the first and the one hundredth transfer are now available. The fermentation products of these culture generations have been determined, both as to quantity and ratio of products, but no significant difference has appeared. Vigor of growth has been maintained and, if anything, has become more regular with successive transfers. Comparisons of spore formation of the first and the one-hundredth culture generations seem to indicate an increase in the number of spores produced. This increase may account for the consistent activity which has been obtained. During this long period of time no culture has dropped out of this series because of failure to grow. This is an unusual record for an experiment with an obligate anaerobe.

(To be continued)

BOOKS RECEIVED

ADKINS, HOMER and S. M. MCELVAIN. *An Introduction to the Practice of Organic Chemistry.* Pp. ix + 224. Illustrated. McGraw-Hill. $2.25.

BEEBE, WILLIAM and JOHN TEE-VAN. *Field Book of the Shore Fishes of Bermuda.* Pp. xiv + 337. 300 illustrations. Putnam's. $3.50.

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EHRET, WILLIAM F. *Laboratory Studies in General Chemistry.* Pp. viii + 312. 21 figures. Century. $1.50.

NAYLOR, NELLIE M. and AMY LE VESCONTE. *Introductory Chemistry with Household Applications.* Pp. x + 367. 41 figures. Century. $2.60.

PARSHLEY, H. M. *The Science of Human Reproduction.* Pp. xv + 319. 66 figures. Norton. $3.50.